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CYLINDRICAL FREIGHT CARS.

Among the numerous plans proposed for providing a lighter class of freight cars for transporting bulky freights, where low rates are absolutely necessary, is the one represented in the accompanying engraving, which has been adapted by Mr. Prestage for an East Indian railway. Freight transportation in India is attended with conditions similar, in many respects, to those existing in many parts of this country; the distances being generally long, and a large proportion of the freights being agricultural produce, which will not bear heavy rates. Under these circumstances, it is especially desirable that the dead weight should bear as small a proportion as possible to the paying load, and this illustration,

FIG. 1.

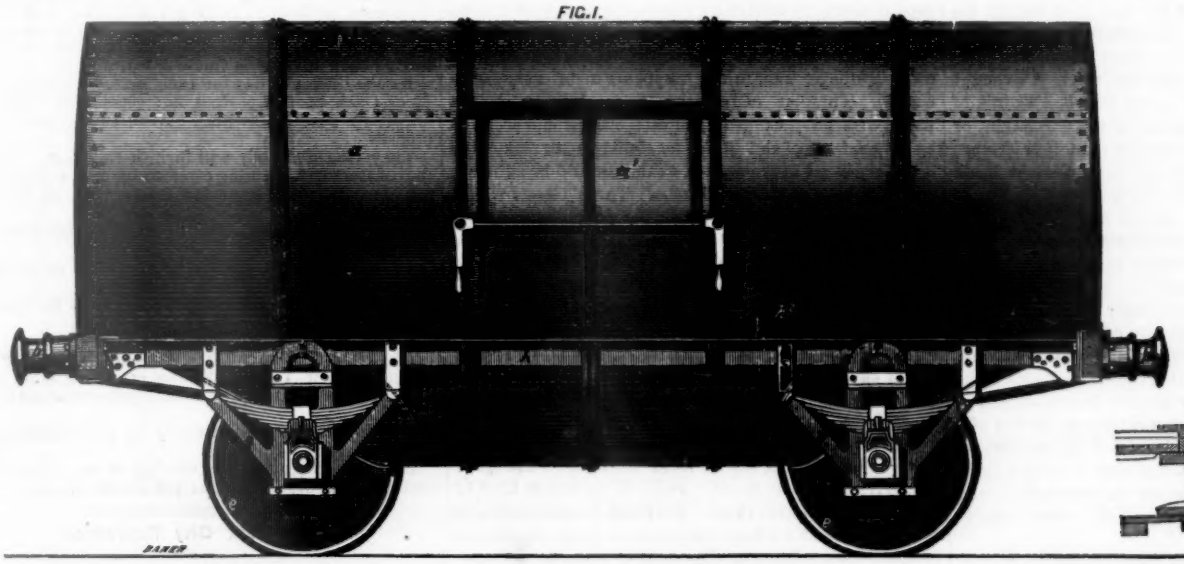


FIG. 10

FIG. 11

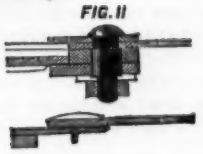


FIG. 2. FIG. 3.

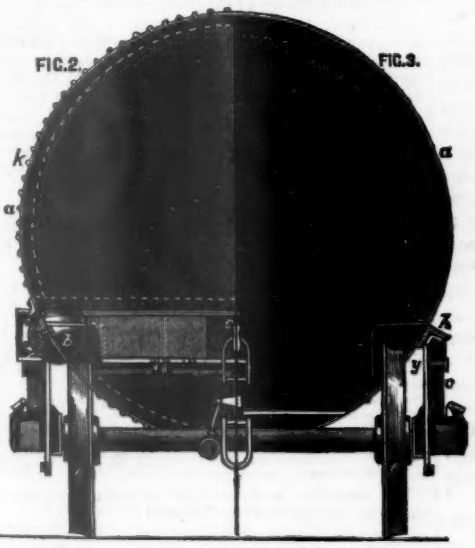


FIG. 4

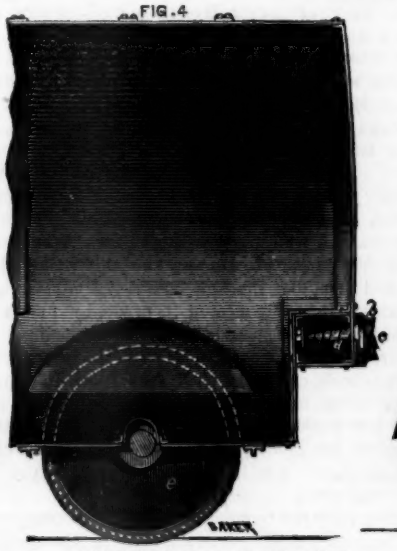
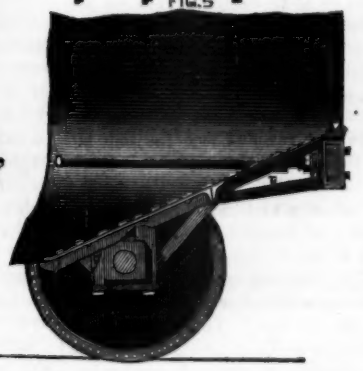


FIG 6 FIG 7 FIG 8 FIG. 9

FIG. 5



Cylindrical Iron Freight Car.

which we reproduce from the London *Engineering*, may furnish some hints from which American car builders may derive benefit.

The general construction of this car, which is built entirely of iron, is quite clearly shown by the engraving. The cylindrical body is 18 feet 6 inches long by 8 feet in diameter, the capacity being 875 cubic feet, and the weight 4 tons 19 cwt. The upper part of the body is formed of 1-16 inch steel plates, while the sides are of ⅛ inch iron plates, and the bottom of 5-32 inch iron plates. The doors are at the sides and the details of their construction are shown in figures 10 and 11, while figures 6 to 9 show alternative modes of connecting the body and frame, and figures 4 and 5 show methods of forming the ends of the body so as to clear the axles.

Contributions.

THE LOCOMOTIVE PRACTICALLY CONSIDERED

Construction, Repairs, etc.

BY WM. S. HUNTINGTON.

Have you ever read Oliver Wendell Holmes' poetical and logical story of the "Deacon's Wonderful One Hoss Shay?" It was of a Deacon who argued that a chaise, if rightly made, would wear out but never break down His reason for a chaise "breaking down" was that there is always some where a weakest spot, and if "these places were made as strong as the rest," the vehicle would stand the wear of an hundred years. In accordance with these views he superintended the building of a chaise for the parson, selecting every piece of wood, leather, iron and steel with great care, and after much trouble the material was fashioned into a chaise whose every part was so proportioned that there was no "weakest spot," each part being exactly strong enough to bear the strain and nothing more. Parson after parson passed away, and the Deacon's master-piece was as strong as ever, until on the morn of its hundredth year, when the one-hoss shay showed signs of age:

"A general flavor of mild decay—
But nothing local as one may say.
There couldn't be—for the Deacon's art
Had made it so like in every part
That there wasn't a chance for one to start;
For the wheels were quite as strong as the thills,
And the floor was just as strong as the sills,
And the panels just as strong as the floor,
And the whipple-tree neither less nor more,
And the back cross-bars as strong as the fore,
And spring and axle and hub *encore*.
And yet *as a whole* it is past a doubt
In another hour it will *be worn out*."

The parson was taking his morning ride, when, at the hour the chaise was one hundred years old, he suddenly found himself sitting astride of a heap of ruins. The "shay" had gone to pieces.—

"All at once and nothing first—
Just as bubbles do when they burst—
The poor old shay in a heap or mound,
As if it had been to the mill and ground."

Although this may not be considered very sound logic, it would be well if locomotive builders would act on the Deacon's principle of making "each part as strong as the rest." We cannot reasonably expect that a locomotive could be so constructed that it could be determined at what precise moment it would be metamorphosed into a scrap heap as was the "one-hoss shay," but it is possible to so improve the construction of parts not liable to breakage, or rapid wear, as to greatly reduce the liability to accident and expense of repairs. There has been a time in the history of railroading in this country when the locomotive was a credit to American mechanics, and some of the finest specimens of good workmanship to be found in this country was turned out of locomotive shops. That was when the demand for locomotives was not so great as it is now, and the few leading manufacturers then engaged in the business gained an enviable reputation, both for the quality of the material used and the honesty with which the work was performed. Now, however, locomotives like other

wares are *made to sell*, and some extensive establishments are taking advantage of the increasing demand and are turning out locomotives that are a disgrace to American mechanics. Not that our mechanics are not as skillful as ever; but so long as shammily built engines can be readily disposed of, employers are satisfied with third-rate workmen who can be had at cheap rates, and even first-class mechanics are not allowed sufficient time or opportunity to finish a job in a workmanlike manner.

Many railroad managers are imposed upon by some manufacturers, who have no regard for their reputation for honesty and who have become very expert in covering their faulty work with putty, paint and varnish.

Many a locomotive is purchased at a round price, which, to all outward appearance, is honestly built, but after a few weeks' service is in a wretched condition and must undergo a thorough overhauling at great expense, and in many cases nothing short of a general rebuilding will make it fit for use. Valves are imperfectly fitted and repairs are soon necessary, requiring apparatus for its performance which is seldom at hand on new roads, and the machine must be sent to the shop of some neighboring road for repairs. Parallel rods, crank pins, spring hangers, etc., are frequently made too small to bear the strain imposed upon them, and the material of which they are made is of the cheapest kind and wholly unfit for the purpose. The castings of driving wheels are frequently of the most treacherous nature. Sand-holes, flaws and cracks of frightful dimensions being nicely filled with putty, the painter's art hides the defects until the manufacturer has received his pay and turned his back on the purchaser, who discovers the imposition when too late. It is the practice with some manufacturers to use cast iron where none but the best wrought iron or steel should be used, and this is a source of great profit to them and annoyance to the purchasers or owners. Locomotives turned out by these builders are loaded down with huge, awkward-looking castings, made large for the double purpose of ease and convenience of construction, and as a ready means of disposing of a cheap material at highly remunerative prices. We often see a 300 lb. casting attached to the tender for a draw-head, and the piles of fragments of these enormous castings, to be seen lying about repair shops, are indisputable evidence of the superiority of the light, tastily formed draw-head of forged material over the casting, notwithstanding its tremendous weight.

Cast-iron steps are often suspended to cast supports, which are liable to be broken at any time by the fall of a stick of wood; rock shafts are supported by cast brackets, which are liable to be broken at any time by a little carelessness; the front shackle-bar is attached to the front beam by a cast knuckle, which is wholly unreliable.

A great deal of shammy work may be found in imperfectly fitting bolts. It appears to be a difficult matter for some mechanics to drill a round hole, or at least they neglect to keep their drills in a condition to bore a true hole, which is essential to a good job; and the necessity of early repairs to locomotives are due in a great measure to this cause. The manner in which a locomotive tire is bolted on in some shops is truly wonderful. The holes are drilled with a *slant*, so as to bring the nut to one side of the centre of the rim, thus leaving no bearing for the nut except on one corner. Sometimes no nut is used, the bolt being riveted, and the bolts are not counter-sunk, or tapered (which is preferable). Tires frequently become loose in a short time after being put in use, or if the tire remains fast the bolt becomes loose, when it is necessary to taper the holes, make new bolts to fit them, and chip away the casting on the inner side of the rim to form a seat for the nut. These bolts should be tapered 2½ or 3 inches, nicely turned to a true fit and driven home with moderate blows of the sledge, (not hard enough to strain the tire). A nut should be screwed on a well fitted seat, and the bolt well riveted on the nut.* This would be a small matter while in the shop of the manufacturer, but it often gives much trouble to railroad mechanics. Counter balances are often loose after a few day's use, and it is owing to these seemingly trifling faults in construction, that railroad companies are subjected to such enormous expenses for repairs to locomotives.

What is more annoying to an engineer on a new road with a new locomotive than to be continually bothered by heating of journals, caused by badly fitting driving-boxes? or perhaps the man who fitted them neglected to make proper provisions for oil to reach the bearings.

*Some mechanics prefer to fasten tire with set screws from the inner sides of the rim, while others do not approve of this method. The plan of bolting through the tire as explained above is not satisfactory in all respects, especially as it greatly reduces the strength of tire; but if the job is well done it appears to be the best plan of fastening yet devised, all things considered. A better mode of fastening is much needed, and the inventor who will produce it will be entitled to the thanks, at heart, of the railroad community.

And so there are hundreds of matters connected with the construction of locomotives, some of which are important and others, though not separately of vital importance, yet in the aggregate detract materially from the value of the engine.

Although we should not expect a locomotive to run a hundred years without repairs, as did the Deacon's "shay," yet if honestly built there is no reason why one should not be fit for duty until necessary to go into the shop for general repairs. At all events there are locomotives turned out at some establishments that do not require any repairs, excepting such tinkering as may be done in the round-house, until a thorough overhauling is necessary. The managers of these establishments regard a good name as good as gold, and it brings gold to their pockets, for they never experience a lack of orders; while the business of other manufacturers of locomotives is lively only when there is an excessive demand which reputable builders are unable to supply.

The ornamental work put on locomotives by some builders is a nuisance. Sharp, angular grooves and bead-work afford receptacles for dirt and grease, which is removed with difficulty, and much of the fancy work is in bad taste. Plain surfaces are preferable in any machinery, and especially in the locomotive. Some builders take especial pains to have all corners rounded, and their style of ornamental work such as may be easily kept clean, which is a matter of importance.

The railroad companies suffer great expense and inconvenience by not having their locomotives built with their parts interchangeable. By so doing the expense of repairs would be materially lessened, and it would seem that first cost might be reduced thereby. This plan is being adopted on a few roads that manufacture their own equipage, and, thus far, appears to be very satisfactory. The plan of building locomotives in classes, with parts interchangeable in each class would seem to be a good one, and it is for builders to take the initiatory steps in the matter, as they would be as much benefited by it as their customers. Three classes would be sufficient for most roads, viz.: the switch engine, and the freight and passenger engines. The peculiar traffic of some roads might demand more than one class of freight engines, but in most cases one class would be sufficient. Although this matter is receiving the attention of some railroad men, they do not generally seem to take the interest in it that its importance demands. Old roads would have to bring about the change gradually, but new roads could receive the benefits of the system at once.

SECOND-HAND LOCOMOTIVES.

As a general thing second-hand locomotives are poor property. They are unsafe; and it is the worst kind of economy to purchase them. Their age is as uncertain as an old maid's, and it is morally certain that no railroad company ever wishes to dispose of a valuable locomotive. There are hundreds of these engines now in use that have been tinkered and doctored for years: the boilers have been patched until it is uncertain whether it is the same boiler or not. Some of them have gradually worked their way from Boston to Texas and other Western States, stopping on their way to perform a few years' labor, when they are patched a little, receive a new coat of paint, and with a shining smoke-stack takes another journey of a few hundred miles with some contractor, who, after his work is done, turns them over to some one else who wants a *cheap engine*. What becomes of all these engines? Do they run their allotted time out, and then, like the "one-hoss shay," fall into a heap of ruins? Probably most of them do, by means of an explosion. There should be a law compelling boiler makers to mark the date, or at least the year, when a boiler is built, on the boiler in some substantial manner, so that its age may be known to a certainty. Then another law would be necessary, making it a punishable offence to continue a boiler in use beyond a certain age. This might, and would, no doubt, prevent many disastrous explosions.

In regard to the "coming locomotive," we may reasonably hope that builders will improve in the quality of their work so as to keep pace with the improvements in material. Recent improvements in iron and steel for locomotive building are highly satisfactory, and if locomotive manufacturers can be persuaded that "honesty is the best policy," the American locomotive will soon be all that is desired in every respect.

Chinese Labor.

Mr. B. J. Dorsey, of San Francisco, whose business is to furnish Chinese laborers to those who may wish, publishes a circular, which gives some interesting details concerning the conditions and security of contracts for laborers, their rations, privileges, etc. We copy from it the following paragraphs:

With regard to the security offered to the employer of Chinese, I beg to state that the faithful performance of their contract is guaranteed by respectable Chinese merchants residing in San Francisco, in the following manner:

The Chinese immigrant in China, wishing to immigrate to California, gives as security to the Chinese merchant of China, for the faithful performance of his (the laborer's) part of the contract, the whole of his family, from his grandfather down to his younger brother and sister, and should he abscond, on his arrival in America, he is well aware that his family in China may be impressed until the amount of his passage money is refunded. On his arrival in California, as soon as found in employment, he invariably makes a monthly remittance to his family, and the Chinese merchant in San Francisco reserves a certain amount monthly from his wages towards liquidating his indebtedness for expenses incurred in bringing him to America. The Chinese merchant in San Francisco assumes full control of the laborer until he (the laborer) has fully compensated the merchant for all expenses incurred since leaving China.

On the other hand, the laborers form themselves into a mutual beneficial society, for their own protection; and in case one should abscond, the remaining ones are bound to pay, *pro-rata*, all expenses incurred, up to the time of absconding.

All orders must be given through the interpreter, or (as they call him) "No. 1 man," whose wages are from $40 to $50 per month. He is the Chinese overseer and accountant. And under no circumstances must they be punished or censured, except through the "No. 1 man." They do not require watching, merely to be shown what is required of them.

The last laborers that I shipped from San Francisco were obtained for $14 per month (gold), and transportation to be paid from San Francisco to destination, only, and nothing to be deducted from their wages, on account of the amount paid for transportation; the contractor feeding them, at his own expense, as per annexed ration table: the cost of which, you will readily perceive, to amount to from $7 to $9 per month for each laborer. I wish to state, also, that they are subject to medical examination. They are likewise remarkable in the fact of having been invariably innoculated.

Ration table per day for each man.—Rice, 2 lbs.; tea, ⅛ oz.; fish, beef or pork, 1 lb.; vegetables, ½ lb.; lard or oil in small quantities. Also, eating and cooking utensils.

They (the Chinese) will furnish their own bedding; the contractor furnishing comfortable and weather-proof quarters, the contractor furnishing, also, all tools and implements.

Days lost from sickness to be deducted from their wages.

All accidents from machinery, etc., to be at the risk of the contractor.

Medicines and medical attendance to be furnished by the contractor free.

Month to consist of twenty-six working days.

The laborers to have three days holiday during their (Chinese) New Year; festivities occurring in, or about the month of February or March, (varying slightly each year).

Laborers to be paid monthly in United States gold coin.

Wages to commence on the day of reporting to the contractor, at destination, as per contract.

New York City Railroads.

Secretary Moore of the Sixth avenue line has prepared a statement, from sworn returns, of the business done last year by the eleven railroad companies for city travel in this city. The eleven companies carried over 113,000,000 of passengers, and received, with the fare at six cents, $1,132,000 more than if the fare had been but five cents. Exclusive of the Fourth avenue line, the other companies collectively paid to the General Government $208,446.97 as the tax on their earnings, which will be about the amount of revenue, per annum, that the Government will give up, after the 1st of October, on the receipts of the companies in this city.

The following table exhibits the number of passengers carried last year by the roads respectively, and the amount netted from the extra cent:

Companies.	Passengers.	One cent.
Third-ave	25,000,000	$25,000 00
Eighth-ave	14,009,267	140,092 67
Dry Dock, E. B. and B	12,355,344	122,553 44
Broadway and Seventh-ave	11,532,259	115,322 49
Sixth-ave	11,287,530	112,875 30
C. P. N. and E. River or Belt	9,638,797	96,387 97
Second-ave	8,723,857	87,238 57
Fourth-ave	7,583,297	75,832 97
Forty-second-st	6,114,229	61,142 29
Bleeker-st	5,458,084	54,580 84
Ninth-ave	1,736,093	17,360 93
Total	113,268,426	$1,132,684 26

The expenses and receipts of each company during the same period were as follows:

Companies.	Total expenses.	Total receipts.	Rec'ts more than exp's.	Expenses more than receipts.
Dry Dock & E. B'y	$612,269 86	$738,600 69	$126,330 83	.....
Second ave	480,866 10	627,472 28	146,606 18	.....
Third ave	1,366,180 32	1,405,129 82	138,949 50	.....
Fourth ave	*	*	*	*
Sixth ave	626,308 41	713,499 47	87,191 06	.....
Bw'y & Seventh av.	587,440 24	713,423 32	125,983 08	.....
Eighth ave	704,937 79	835,446 87	130,509 18	.....
Ninth ave	118,049 94	110,179 16	.....	$7,870 78
Belt R. R. or C. P. & N. E. Rivers	617,315 81	583,491 14	.....	$33,794 67
Bleecker st. & F. F'y	301,422 94	334,092 88	33,669 94	.....
42d st. & Grand st. Ferry	288,863 01	376,903 21	94,040 20	.....
Total	$5,597,354 42	$6,438,168 84	$882,279 97	$41,665 45

*Merged in those of the New York & Harlem Railroad. This company is not subject to reduce the fare on the Fourth ave. cars to five cents.

The income which the several lines received last year with the fare at six cents, what they would have received had the fare been five cents, and the difference between the former and latter is shown in the following comparative statement.

COMPANIES.	Receipts at 6 cents.	Receipts at 5 cents.	Differences.
Dry Dock & East Broadway	$735,314 94	$612,762 45	$122,552 49
Second ave	523,431 45	436,194 85	87,238 60
Third ave	1,386,634 41	1,155,528 70	231,105 71
Sixth ave	677,351 80	564,476 5	112,875 30
Broadway & Seventh ave	690,968 10	575,806 75	115,161 35
Eighth ave	84 ,556 02	700,463 35	140,092 67
Ninth ave	103,565 68	86,304 65	17,260 93
Belt	578,327 84	481,939 8	96,387 99
Bleeker st	326,569 22	272,141 00	54,428 22
42d st and Grand st. Ferry	366,847 73	305,796 45	61,141 28
Total	$6,229,467 09	$4,191,225 55	$1,037,264 54

What companies would have made money last year with the fare at five cents, the companies that would have lost at a five cent rate, and those that did lose even at the six cent rate is shown as follows:

COMPANIES.	Gain at 5 cts.	Actual loss.	Actual loss at 6 cents.
Dry Dock & E. Broadway	$3,778 34	.....	.....
Second ave	.....	$40,633 43	.....
Third ave	.....	23,816 92	.....
Sixth ave	.....	25,684 24	.....
Broadway & Seventh ave	10,821 73	.....	.....
Eighth ave	.....	9,583 49	.....
Ninth ave	.....	25,131 71	$7,870 78
Belt	.....	130,182 66	33,794 67
Bleecker street	.....	21,7:8 28	.....
42d st & Grand st. Ferry	32,898 92	.....	.....
Total	$47,498 99	$276,789 72	$41,665 45

RECAPITULATION.

Number of passengers last year over all lines in the city	$113,000,00
Total receipts of all the companies, except the Fourth ave	6,400,000
Total expenses of the same, about	5,600,0.0
Amount that the one cent above five netted the companies	1,100,000
Amount received from passengers, exclusive of Fourth ave	6,229,467 08
At five cents the same companies would have received only	4,191,325 55
Companies that last year would have made money at five cents	3
Companies that would have lost money at five cents	7
Companies that actually lost money last year	2

These include the amount received by the sale of old iron, broken down horses, and the rental of real estate.

The following shows when the roads were opened, the length of each road, the number of cars in use, also of horses and the total amount which each company (except the Fourth ave.) paid to their conductors, drivers, or engineers on dummy cars, starters, switchmen, roadmen, and watchman collectively last year:

COMPANIES.*	When Opened.	Miles Length.	No. of Cars.	No. of Horses.	Paid. Conduct.
Dry Dock & E. B	1866	25	110	806	$197,202 84
Second ave	....	8	101	661	158,142 81
Third ave	1854	8	183	1,600	430,387 58
Sixth ave	1852	4	76	771	161,165 64
B'wy & Seventh ave.	1864	8	109	778†	140,190 50
Eighth ave	....	10	157	.	168,748 77
Ninth ave	1859	13	50	210	33,555 33
Belt	1864	22	143	809	151,375 34
Bleeker st.	1866	9	50	400	63,864 42
42d st. & Grand st. F.	1864	5	53	497	80,112 10
Total		112	1,081	6,461	$1,584,745 33

*The Fourth ave line is the oldest. It was opened in 1832. Number of cars, 88.
†Including mules.

Had the fare been five cents last year on the Third avenue line, the receipts would have been less $23,816.92, and with the Van Schaick judgment included, that was in litigation ten years, the loss would have been $92,-156.21.

LEGAL ASPECTS OF THE QUESTION.

Though none of the companies have yet determined on demanding five cents fare in gold, or its equivalent in currency, after the first of October, some of them have obtained legal advice, from which they receive assurances that the extra demand is proper and legally sanctioned, because the charters were granted prior to the time of paper currency. Again, the advice points to the fact that there are decisions of the courts extant maintaining that passengers must provide the exact fare if the company insist upon it. In the event of the companies demanding the equivalent of gold, with gold at 15 per cent. premium, the fare would be five and three-quarters cents in currency. The passengers would not be able to make this fraction, and the company not being compelled to provide change, the fare would remain the same as it is now. The companies have thus refrained from claiming the rights for the sake of peace, and to avoid daily conflicts with passengers. It is believed by the leading officers of those companies which have declared dividends, that if it is determined to run the cars for five cents fare, currency, those holders who bought stock when the extra cent was added, will sell out as soon as they can, to avoid the possibility of being called upon for assessments in the event of the roads failing to pay at five cents currency, while other stockholders will hold on to their stock, expecting that the roads will come up again when there is a return to specie payment.—*New York Tribune.*

—Two competing submarine cable companies, the China Submarine and the Great Northern and China Extension, have agreed to work together and divide receipts. The lines from Singapore to Japan are to be finished before the end of 1872. The combination is for thirty years.

—The Erie & Atlantic Sleeping Car Company is the organization which owns and runs the sleeping cars over the Erie and the Atlantic & Great Western roads. Wm. R. Barr, General Ticket Agent of the Erie Railway, is President of the company.

High Pressure Boilers.

The first steam boiler of which any reliable account exists, was patented by Captain Thomas Savery in 1698, and it was unquestionably a high pressure one. This is abundantly proved by the fact that Savery raised water 80 feet high by the direct pressure of steam; for which purpose a pressure of 35 pounds per square inch would be required. He also speaks of raising water in the same way "500 feet or 1,000 feet high" could he find boilers strong enough to withstand so great a pressure. Although this statement, on his part, cannot be taken as evidence of his contemplation of an increase of pressure up to the precise point indicated—430 pounds, yet it shows that he was well aware that very much higher pressure than he was using could be attained. The Marquis of Worcester, in a manuscript written in in 1655—which is now in the British Museum—speaks of having forced water to a height of 40 feet, "like a constant fountain-stream." If his meaning is that he raised water to that height in a pipe, we must conclude that he used steam approaching 20 pounds; but if his words be taken to express forcing water in a jet, and the phrase "like a constant fountain-stream" seems to bear such a meaning, a pressure considerable higher would be indicated. His acquaintance with very high pressure steam is further shown by his experiments with cannon, which he closed up with a certain quantity of water inside, and then burst by the action of fire. Following the Marquis of Worcester and Captain Savery, we find Newcomen and Cawley, of Dartmouth, laboring at the production of the arrangement commonly known as Newcomen's engine. This was emphatically a low-pressure engine; in fact, rather an atmospheric than a steam engine. The steam used in such an engine did not exceed 16 pounds above a vacuum, the temperature being 216 deg. Fahr.

The power was, therefore, really obtained from the atmospheric pressure, and the vacuum produced by condensing the steam. Although the credit of the construction of this kind of engine belongs to Newcomen chiefly, and in some degree to Cawley, yet the honor of the great discovery of producing power by the condensarion of steam undoubtely belongs to Savery. In fact, his claim to this great invention was acknowledged by both Newcomen and Cawley. Smeaton and Brindley were also among the pioneers of low pressure. At length the illustrious Watt did all that could be done in this direction, and attention began to be turned to the advantages of high pressure steam; though not till low pressure had been carried to such preposterous lengths, that boilers made partly of wood and lead were used; nay, even boilers built of masonry were propsed if not actually made. Many profound mathematicians investigated the theory of heat and expansions; and, as the advantages of using steam at high pressures became more and more manifest, many able practical men took the matter in hand. Amongst these may be mentioned Woolf, Trevithick, and Perkins, in England, and Oliver Evans in America.

At the outset, the advocates of high pressure had many disadvantages to contend against in the prejudices and ignorance of the time, and still more in the danger arising from the use of so untrustworthy a material as cast iron in the construction of their boilers. Many of these boilers burst; and, from their extreme brittleness, they very much resembled "infernal machines," scattering death and destruction all round Very many boilers were made of copper, but finally copper boilers were mostly displaced by wrought iron ones: though even now, we believe, many copper, and even some cast-iron boilers, are at work. The first wrought iron boilers which were made were the Waggon boilers with plain sides and arched top. These boilers were neither suited to generate steam economically nor to withstand much pressure. The next step was to curve the sides inwards, thus improving the economy of the boiler to some extent. We find this form of boiler speedily further improved by rounding the ends, and finally the bottom. So many accidents occurred with these boilers that it was evident further safety must be sought.

As the Waggon boilers required many stays to keep them from "going out of shape," some boilers were made completely spherical. These spherical boilers gave the full tensile strength of the metal, except inasmuch as they were out of a true sphere by reason of the lap-joints. They were, however, deficient in heating surface, and very subject to burning through at the bottom by the collection of mud and scurf. Improvement was therefore sought by making the bottom considerably flatter than the spherical form.

The desire for heating surface caused the alteration into the well-known Haystack or Balloon boiler. Very great numbers of these boilers were used, particularly in Staffordshire and the district, many being as much as 20 feet in diameter. From their inherent weakness and great size they were terrible "magazines of death." Such great numbers having been used, explosions amongst this class have been very numerous. Owing to this cause, and also to their containing so large a volume of steam and water, a greater amount of destruction of life and property is chargeable to them than to any other form of boiler. A very considerable advance was made by the construction of the Cylindrical boiler. These were first made with straight seams and flat ends, but were soon improved by making the seams of rivets break joints, and by the addition of hemispherical ends.

These boilers, however, are very objectionable. They suffer a great strain through the unequal expansion of the top and bottom. They have been made even as long as 100 feet. At such an extreme length this inequality of expansion would be very considerable—though to some extent dependent on the kind of iron used in the boiler, as well as in the temperature—and often explosions thus ensue from the "breaking of the back" of the boiler. To keep the diameter of these boilers within bounds, the French have largely employed the compound form known as the Elephant boiler. A boiler slightly differing from this in detail, but on the same principle, bears the name of the Retort boiler. The next improvement aimed at economy, and gave us the Cornish boiler. To obviate the weakness of the larger flued boilers of this class, Mr. Fairbairn introduced the double-flued boiler, about twenty-five years ago.

These boilers are very safe, and in somewhat extensive use, though by no means to the extent they merit. Considerable numbers of Butterley boilers have been constructed, but although they are economical, they are very weak against pressure, and therefore proportionately dangerous. Many minor varieties of boilers might be mentioned. One class of boiler—from its dreadfully destructive nature—claims attention, namely, the class used in iron-works. These boilers, surrounded by brickwork, and exposed to the fierce flames from the puddling furnaces, would be sufficiently destructive in any ordinary situation; but, placed as they are, in the very midst of a number of men, amongst whom, when they explode, they scatter a death-dealing shower of bricks, iron and water, with the frequent addition of some of the hot iron from the furnaces, the carnage produced is often frightful.

The Multi-fluid boiler, demands but little notice, as it has not been found satisfactory in practice, since its economy in fuel is more than counterbalanced by its being troublesome to clean. The Multitubular boiler is still more economical in fuel, but also still more difficult of access for cleaning. It is also liable to leak at the bottom, and from those two causes is wanting in durability. Amongst the improvements made in boilers of late years Adamson's flanged joints in internal flues, and Galloway's conical tubes occupy most important places. The strength afforded by the flange joints is very great, and when the frequent collapse of long flues is taken into consideration, is very important. Galloway's tubes only materially strengthen the flues, but they also add a most efficient heating surface, as the flame and gases strike almost at right angles to the metal, while the water rises at a slight angle from it, the best posible conditions for evaporation—and thus they are valuable economisers of fuel. They also cause a very brisk circulation, which further tends to economy, and to the preservation of the boiler by equalizing the temperature of the water throughout, and so preventing unequal strains. It is probable that if inner tubes were added that the efficiency would be still greater, as such inner tubes would separate the water into two currents, upwards and downwards. All the boilers we have hitherto noticed, differing as they do largely, *inter se*, have one peculiarity in common, namely, that they each contain a large volume of water and steam. In case of an explosion there is, therefore, a correspondingly large supply of destructive material Further they are each to some extent deficient in economy of fuel, as they allow the heated gases to *slide* to too great an extent along their heated surfaces, not breaking up the current sufficiently; and they are also, as a rule, wanting in circulation. These last objections do not apply much to Galloway's boiler, the first does. Many attempts have been made to construct boilers so as to be free from these objections, and also to carry high pressures. An early laborer in this field was Dr. Ernst Alban, of Plau, who produced a very able and exhaustive treatise on boilers about a quarter of a century ago. He discusses pressures up to 1,000 lbs. per inch. He was the originator of some very ingenious water-tube boilers. As these boilers have, however, become obsolete, they hardly will fall within the scope of the present article. James and others proposed tubular boilers, having an extra inner tube to promote circulation. These inner tubes by no means answered the purpose for which they were intended, as the upward and downward current met each other at the tops of the two tubes—inner and outer—and the circulation was far from being satisfactory. Mr. Field combatted this difficulty by splaying the top of the inner tube, which thus become trumpet-shaped. That the "Field" tube answered its purpose may be gathered from the favor it enjoys and the large number—upward of 60,000—in use. It has been found extremely applicable to fire engines, as it is a very rapid generator, so much so that steam of 100 lbs. per inch has been raised from water at 45 deg. Fahr. in 7½ minutes, in a boiler fitted with these tubes. These boilers are extremely suitable where quickness, high pressure and economy in fuel are required; and where constant and competent supervision is given to the firing and "feeding." They are not likely, however, to be generally adopted for factory and other uses where more liability and neglect exists.

We have now to notice a boiler which is, perhaps, in most respects the best yet introduced. The one we allude to is Howard's Safety Boiler. This boiler possesses the following requisites of a good steam generator: It affords ample heating surface of the very best kind for efficiency, as the flames and currents of gas are thoroughly broken up by the alternations of the vertical tubes. It offers a maximum amount of safety at high pressures; in fact, it is doubtful whether more than *one* tube would go at a time, even if an explosion did occur, which is very unlikely, as the tubes being small are of enormous strength, and are further, by reason of their shape, subject to simple tensile strains only, and therefore no very extensive damage could be likely to accrue. It also acts as a very efficient superheater, thus giving the two great advantages of very high and perfectly dry steam. Inasmuch as corrosion and scaling are undoubtedly the two most serious evils which have at all times attended boilers, so must importance attach to the fact that in Howard's boiler so good a circulation is obtained as to do away with the accumulation of scale. A further great advantage lies in its non-liability to injurious strains, as its construction admits of its yielding in all directions to the expansion and contraction consequent on changes of temperature. This boiler is also remarkably easy to repair. The only drawback to it lies in the rapidity with which the water will rise or fall in it. This difficulty is nowadays met, to a great extent, by Giffard's injector; but it must be borne in mind that the very class of users *most* likely to neglect their boilers are also *least* likely to adopt so beautiful a contrivance as the injector. In fact, the writer himself some little time back

took out an old feed pump and put an injector in its place, which gave the utmost satisfaction. Some little time after the boiler passed from under his control, when the pump was reinstated, merely on the plea that the injector was "too scientific."

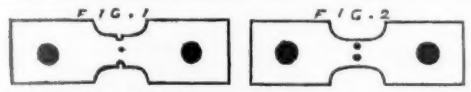
As regards the future of steam boilers, we may expect that high pressures will continue to become more general as their economy is more widely appreciated. At the same time, let us hope that the increased dangers resulting may be guarded against by an efficient system of inspection and improved workmanship and materials in the boilers, with the more extended use of double lock-up safety valves and alarums, fusible plugs, and trustworthy water and steam gauges *in duplicate*. At the present time it is dreadful to contemplate the number of boilers working literally at random. The water went a few days back to a place where they had had an explosion of a boiler, which, though unfortunately unattended by loss of life, had been fearfully destructive. Yet, notwithstanding this severe lesson, they had actually put down an externally-fired cylindrical boiler—a most unmanageable and mischievous form—without water or steam gauge, or even a fusible plug or alarum: its sole safeguards being a float with a stuffing-box, and a most inefficient safety-valve weighted to *sixty pounds*. At the time of our visit the steam was blowing off furiously, so that the pressure must have been much above 60 lbs., very likely nearer 100 lbs. per inch. The danger was by no means diminished by the fact that the boiler was made with lap joints, and, of course, single riveted.

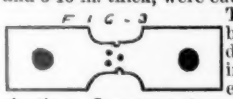
If cylindrical boilers are to be used at high pressures, the bodies and flues ought to have the longitudinal joints welded, and each length rolled to a truly circular shape. The transverse joints ought all to be double butt joints, and the plates thick edged, on Alton's plan. As regards rolling a tube, why should not complete bodies and flues be rolled at once? It is only a question of size of machinery and careful design. The demand for such boilers could not fail to be large.

It is very probable that far too little attention has been bestowed on the electrical influences brought to bear in corroding the iron of boilers, where the plates and rivets differ in amount of carbonization, &c. Bessemer steel offers a very suitable material for boilers of all kinds, and of late very considerable advance has been made in its application. As a proof of this it may be mentioned that up to March, 1868—since which we have no return—three firms in Lancashire had turned out no less than 277 steel boilers, and 152 composition boilers, partially of steel.

That these numbers are far under the mark now may be inferred from the fact that the demand was then rapidly increasing As steel of great ductility can be got capable of bearing an ultimate strain of 33 to 35 tons per square inch, the very great superiority of such a material to iron, only capable of bearing 20 to 22 tons, needs no lengthened comments. The use of steel for boilers has been much restricted by the general impression that the steel *must* be drilled and not punched. That drilling is, *per se*, better than punching we feel convinced, but is it not just as superior for iron as steel, it the latter be afterwards annealed?

With regard to punching steel plates, we have before us the results of a very careful set of experiments carried out by the Bolton Iron & Steel Company, and, from their important bearing on the question of increased safety with high pressure boilers, we give the tabulated results. Six pieces 23 in. long by 7 in. broad and 5-16 in. thick, were cut from the *one* steel plate.





Three of these were prepared by punching, and three by drilling, with $\frac{5}{8}$ in. holes, $1\frac{1}{2}$ in. from centre to centre, suited for single and double riveting. In a strapping machine these were then cut to the forms shown in Figs. 1, 2, and 3.

They were tested in a lever machine by dead weight. The results are given in table I.:—

TABLE I.*

Number of Test.	Thickness.	Area.	Breaking weight on Lever.	Weight per sq. in. of section drilling.	Weight per sq. in. of section punching.
			Tons cwt		
1 D.	5/16	0·2437	19 3	35·33	
1 P.	5/16	0·35625	14 17		26·690
2 D.	5/16	0·35	20 10	37·27	
2 P.	5/16	0·3625	13 5¼		23·735
3 D.	5/16	0·3466	19 18	36·40	
3 P.	5/16	0·3593	12 12¼		22·570

*Extracted from Transactions of the Institution of Naval Architects, 1868.

It will be noticed from this table that the punching has a deteriorating effect of 26·4 to 37·8 per cent., being an average of 33 per cent. Examination under a powerful glass revealed the cause of weakness, and led to the trial of annealing. In the following table are given the results of sixteen tests carried out at Chatham Dockyard. The results are furnished by Mr. Barnaby, Assistant Constructor of H. M. Navy.

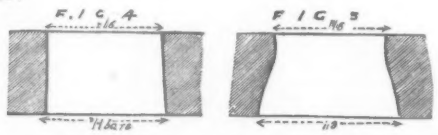
In these experiments eight plates of steel had each four holes of 0·66 inches diameter punched in them. Each plate was then cut in two, and one piece of each annealed. The plates were ½ inch thick. The testing was performed in an hydraulic testing machine. The average ultimate strength of the eight annealed plates rises as high as 32·839 tons per inch of section; that of the unannealed plates was only 21·097 tons. Thus it will be seen that there is a difference of 11·642 tons in favor of the annealed plates, equal to 55·66 per cent. It is further well worthy of notice that the annealed plates are very much more reliable, as they show a difference of only 5·416 tons between the two extremes, while the unannealed vary as much as 9·372 tons.

TABLE II.*

No. of sample.	Size of Sample.	Breaking strain.				Breaking strain per square in.	
						Annealed	Unannealed.
		Tons	cwt	qr	lb		
1 A	2·28x·475	21	0	0	0		Tons. 19·39
1 A	2·28x·475	35	15	0	0	33·010	
2 A	2·33x·478	28	17	2	0		26·369
2 A	2·23x·475	31	15	0	0	29·981	
3 L	2·18x·47	23	0	0	0		24·460
3 L	2·23x·48	37	7	2	0	34·929	
4 L	2·23x·47	23	17	2	0		23·781
4 L	2·23x·48	37	17	2	0	35·397	
5 A	2·23x·475	20	0	0	0		18·385
5 A	2·23x·47	32	17	2	0	30·274	
6 A	2·28x·475	19	10	0	0		18·005
6 A	2·28x·475	33	17	2	0	31·278	
7 L	2·23x·475	18	0	0	0		16·997
7 L	2·13x·475	35	10	0	0	33·252	
8 L	2·28x·475	25	17	2	0		22·891
8 L	2·23x·475	35	17	2	0	33·878	

*Transactions of the Institute of Naval Architects, 1868.

It is advisable in making steel boilers to use double butt joints and double riveting, as otherwise the rivets will sheer with far less than the breaking strain of the plate; unless, indeed, the rivets used be so large as to gain strength to the detriment of the plate. The proportions given by Mr. Henry Sharpe, of Bolton, are for 5-16 in. plates, diameter of rivets, 9-16 in., pitch 1⅜ in., double riveting; material of rivets, mild steel. With these proportions two tests gave the following excellent results, with plates taken at random from a large quantity of steel boiler plates which were being rolled to order by the Bolton company, drilled plate 42·9 tons, and punched ditto, 39·11 tons per square inch of net sectional area. Mr. Sharpe further experimented as follows:



A punch of 11-16 in. was used; first in the ordinary way, with a bed ¾ in. bare, producing the hole shown in Fig. 4; then a bed ⅞ in. in diameter was used, giving the result shown in Fig. 5. The plates were dressed to the form shown in Fig. 6. When tested, which was done without annealing, the taper-holed plates gave an average of 32·527 tons per square inch of net sectional area; the plates with straight holes, 26·004 tons. These taper holes must offer advantages to riveting up.

It is certain that the desire for economy will lead to the more extensive adoption of high pressures, heated feed-water, and the super-heating of steam. As regards the heating of feed-water we may notice "Green's Economizer" as a very efficient apparatus. Its chief peculiarity, as is well known, consists in the scrapers—which are very slowly moved up and down by simple gearing—to clear off the soot from the pipes through which the feed is passed. By this clearance the pipes are kept efficient in absorbing heat. Very considerable saving of fuel has been effected by the use of this apparatus. Water's heater is exceedingly suitable for non-condensing engines. It possesses the advantage of thoroughly heating the water to the boiling point, and also of causing the deposit of its earthy matters as mud in the heater. With the increase of pressure, the frequency and destructiveness of boiler explosions will increase unless efficient means be taken to combat the dangers spoken of.

Any one who will read the reports of any of the very excellent boiler associations will be convinced that, if boilers were all well made to begin with, as regards workmanship, design and material, well mounted, with efficient duplicate safety-valves (locked), water-gauges, alarums, steam-gauges, and fusible plugs, and finally, properly inspected, explosions would be few and far between. It is to be hoped that the bill on this subject, introduced by the honorable member for Dudley may either become law or lead to even more efficient legislation. Let us hope also that the barbarous system of buying boilers at per ton may give way to an intelligent mode of valuation. When this is done, and the great value of pure feed-water recognized, we may expect an explosion to be a rarity.

A further improvement required is the entire remodelling of "Crowner's quest-law," by which a coroner, who knows little or nothing of boilers, is assisted (?) by a jury, who usually are chosen as though it were desirable to get those who know "nothing of anything."

We want a competent tribunal to inquire into all explos'ons, accidents on railways, in mines, &c., whether actually fatal or not. At present we witness this absurdity, that a minor accident may occur by which *one* life is sacrificed, and *two* coroners set to work; on the other hand, an accident which maims hundreds for life will not move one coroner, unless some case of death should result. These are the abuses of a bygone age which have dragged on to the present.—*English Mechanic.*

Historical Sketch of Railway Cars.

The history of car building, although to a great extent unwritten, is nevertheless one of absorbing interest to the builder and owner; and it has often been a source of regret as well as of wonder to the writer that so little has been written upon this subject. The student in this branch of history, as well as the builder, will search in vain for any concise or correct and well-writtten history of this invaluable and indispensable adjunct of railroad traffic. It is, therefore, proposed to give, in a series of articles, a very brief history of the railroad car, from its first introduction to the present time.

The first description of a railway car which the writer has been able to find is that given by Mr. John Francis, in his *History of the English Railway*, in which, speaking of the first tram roads built in England, he says: "The manner of carriage is by laying rails of timber from the colliery down to the river, exactly straight and parallel; and bulky carts are made with four rowlets, fitting those rails." The date at which this first tramroad was constructed is not given; but it must have been later than the year 1670, as that was the time when English coal first began to be extensively used for fuel. The "bulky carts" spoken of were little more than boxes, mounted upon rollers, they being made to contain one ton of coal each. Cars of the form above described continued to be used for several years at the Newcastle mines, during which time other companies adopted them; and they appear to have been used until the year 1738, when cast-iron rails were introduced, and much larger cars were used. But these were found to be too cumbersome, and were abandoned for smaller ones, which were so arranged as to be coupled together. This first step in the improvement of railroad cars was taken in 1768, at which time it is probable that cars were first coupled together so as to form a train.

Shortly after the date last given, brakes were first applied to the wheels of cars, at which time one pair of iron wheels was used upon each car, while the other pair was made of wood; the theory held being that the brake-block, or shoe of the brake, would not act upon the surface of cast-iron wheels. But this fallacy was soon dispelled, and the lever of the brake was lengthened for the purpose of enabling the attendant to press it more firmly upon the wheels, and the brake was applied to the iron wheels, and soon after to all four of the wheels. At about this time the wooden wheels were abandoned, and the cars were mounted upon iron wheels only. This last-named improvement was effected about the years 1770 to 1773.

Up to this time the wheels appear to have been made to fit to some extent the rails upon which they were to run; they being generally supplied with two flanges, the spaces between which were sometimes made flat to run upon a rail, the upper surface, of which was of a similar construction; while others were made to fit a rail having a rounded upper surface, and yet others were so constructed as to fit various other forms of rails.

Cars having wheels with a single flange were placed upon the Penrhyn Railway, in July of 1801. It was soon found, however, that those wheels wore away rapidly, and that great friction was caused in consequence of such wear, and the double-flanged wheel was restored to favor, but in an improved form.

Between the years 1801 and 1821 there does not appear to have been any very striking change in the character of railroad cars, except that they were steadily improving in their details, springs being introduced to carry the body of the car, and thus relieving them of much of the wear to which they had previously been subjected. In the year last named there appears to have been introduced an entirely novel feature in the construction of cars as well as of the tracks or ways upon which they were run.

A single rail constituted the track, and the car or cars were made double, or in pairs; one being suspended upon each side of the elevated rail, by which means two wheels were made to serve the purpose of eight. The wheels were placed one before the other, upon axles of sufficient length to form supports which extended far enough beyond the wheels to receive and carry the car or receptacle for freight; the centre of gravity being always below the surface of the rail, small wheels or rollers being placed upon vertical shafts to bear upon the sides of the track to prevent the car from tilting sideway.

The most important change made in cars was that of M. Thomas Parkins, of France, which was shortly after the last-named date, it consisting of a car having recesses, or grooves, formed in its lower edges, and furnished with iron plates to run upon stationary but rotating wheels, placed at proper intervals, which constituted the track. These cars were propelled or drawn by wind-mills, stationed at proper intervals along the line; ropes or chains being used to connect the cars to the mills. The bodies of these cars were much longer than were those which had preceded them, they being in many respects like those now in use for the transportation of freight.

In 1802, a car, or a combined engine and car, was introduced, which must have been one of the first, if not in reality the first car used exclusively for the transportation of passengers. This car was provided with an engine and all the appurtenances necessary to make it self-propelling, so that it is difficult to determine whether it should be classed as a car or as a locomotive engine, provided with seats for the convenience of passengers. However this may be, it was one of the pioneers in its line, and its originator is entitled to great credit for his skill in constructing and arranging its parts.

In 1816, car-wheels made their appearance, which were made by using cast-iron hubs and rims or treads, the spokes being of malleable iron. This wheel appears to have been a very decided improvement upon any that had preceded it, inasmuch as it was lighter than those with cast spokes, and much more durable than the wooden ones which had so long been used. From what has been said, it will be seen that the cast-iron wheel which is now so extensively used in this country had its origin in England in the early days of railroads in

that country and although our car-builders and car-users still adhere to them with great tenacity, the people of England have, to a great extent, abandoned their use, believing that the wrought-iron tired wheel is, upon the whole, more economical.

In 1826, cars were introduced upon an English railway having an axle for each wheel, each axle extending entirely across the frame of the car, there being two at each end, one of which was placed just far enough in advance of the other to permit the wheel upon the rear one to rotate without coming in contact with the front one. The object of this arrangement was declared to be to "prevent the wrenching of the axles in turning short curves."

Previous to the last-named date, or in 1824, a decided novelty in the form of a railway car made its appearance upon an English road, it having been invented by Mr. William Francis Snowdon, and placed upon the road on the 18th of December of that year. This car was two stories in height, and was circular in form. Upon the lower floor the horses which propelled it were placed; the space within the circle thus occupied being devoted to freight, while the upper story was devoted entirely to passengers, stairways being provided for their ascent to, and descent from, their elevated position. This car ran upon rails provided with cogs upon their inner surfaces, into which pinions placed upon vertical shafts meshed, said shafts being propelled by the large tread-wheel upon which the horses were placed.

This brings us to the end of our first article. In our next we shall continue the subject, and endeavor to give brief sketches of cars which were constructed between the years 1826 and 1850.—*National Car-Builder.*

Governmental Telegraphs.

The *Journal Telegraphique*, published at Berne by the International Telegraphic Bureau, contains in its issue of July 25, 1870, the official returns of the telegraphic traffic in ten European countries for 1869. These reports show an aggregate loss for the past year rather greater than for the same countries in 1868, proving that governmental telegraphs do not approach any nearer to a financial success at the present time than in previous years. The following figures show the traffic in each country for 1869:

North Germany transmitted 4,961,452 messages, receiving therefor $1,519,435.40, and expended $1,740,416.80, being an excess of expenditures over the receipts of $220,981.40.

Bavaria transmitted 428,371 messages, receiving therefor $174,772.60, and expended $350,388, being an excess of expenditures over the receipts of $175,615.40.

Belgium transmitted 1,314,367 messages, receiving therefor $264,554.28, and expended $285,358.40, being an excess of expenditures over the receipts of $20,804.12.

Denmark transmitted 267,126 messages, receiving therefor $79,505.32, and expended $140,039.57, being an excess of expenditures over the receipts of $60,534.25.

The States of the Church transmitted 74,625 messages, receiving therefor $23,564.23, and expended $29,131.10, being an excess of expenditures over the receipts of $5,566.87.

France transmitted 5,398,823 messages, receiving therefor $1,969,902.92, and expended $2,585,799.40, being an excess of expenditures over the receipts of $615,896.48.

Holland transmitted 1,178,444 messages, receiving therefor $231,502.27, and expended $393,642.10, being an excess of expenditures over the receipts of $162,139.83.

Roumania transmitted $506,761 messages, receiving therefor $209,334.50, and expended $283,558.25, being an excess of expenditures over the receipts of $74,223.75.

Switzerland transmitted 1,108,510 messages, receiving therefor $197,532.32, and expended $210,666.04, being an excess of expenditures over the receipts of $13,133.72.

Turkey transmitted 551,126 messages, receiving therefor $1,042,249.03, but as only a portion of her expenditures are given we cannot state the amount of her loss or gain on the traffic.

No reports have been received from the following countries for 1869, but in 1868 their losses were as follows:

Austria and Hungary	$576,201
Greece	8,624
Spain	372,965

making a total of $957,790 for the three countries, which, added to the nine countries from which we have received returns, makes an aggregate loss of $2,306,685.82, or $208,761.82 more than for the preceding year.

The number of employes and amount of compensation per annum in the telegraphic service in the various European countries above mentioned are as follows:

North Germany, 3,947 employes; annual compensation, $1,065,780.80, or $270 each.

Bavaria, 241 employes; annual compensation, $63,304.60, or $262.67 each.

Belgium, 982 employes; annual compensation, $153,383, or $156.19 each.

Denmark, 221 employes; annual compensation, $58,523.76, or $264.81 each.

States of the Church, 121 employes; annual compensation, $21,861.58, or $180.70 each.

France, 4,989 employes; annual compensation, $1,488,000. or $298 each.

Holland, 766 employes; annual compensation, $211,368.42, or $275 each.

Roumania, 966 employes; annual compensation, $261,812.43, or $271 each.

Switzerland, 607 employes; annual compensation, $119,848.17, or $197 each.

Turkey, 2,507 employes; annual compensation, $605,552.64, or $241 each.

Total number of telegraph employes in above-mentioned European countries, 15,347; total annual compensation, $4,049,435.40, or $263 each. Average daily compensation for European telegraph employes, 72 cents each. This includes, also, the compensation of 859 superior officers of the telegraphic administration, which, if deducted, would materially reduce the average pay of the remainder.—*Journal of the Telegraph.*

Prof. Tilman on Improvements in Canal Navigation.

The canals and navigable rivers in the territory of the United States form a network of transit, unrivalled in extent and importance. In the State of New York alone the artificial water channels of communication have a total length of nearly one thousand miles, of which eight hundred and ninety-three miles belong to the State. The connections with rivers and small lakes make the whole distance now navigated by New York canal boats about 1,350 miles. On the twenty canals owned by the State are 565 stone locks, which, if placed in a continuous line, would extend nearly seventeen miles; and the bridges over these canals, if placed end to end, would form a line of equal length. The Erie Canal, seventy feet wide and seven feet deep, is carried over several rivers and large streams on stone aqueducts of unequalled magnitude. Some idea may be formed of the business done on the New York canals by the following official statements: From 1859 to 1866, inclusive, 12,850 canal boats were built and registered, having a carrying capacity of 1,291,497 tons. During those years the aggregate movement on all the canals amounted to 39,433,625 tons. For twenty years preceding 1867, the tolls collected amounted to $65,815,411; the yearly average being $3,290,770. After deducting the cost of maintenance, the average annual surplus revenue from the canals is found to exceed $2,319,500. From 1854 to 1865, inclusive, the average freight paid for moving one ton one mile on the canals, was nine mills and one-tenth of a mill, while the average freight paid during the same time for moving one ton one mile on both the New York Central and Erie railroads, was 2 41-100 cents, showing that during those years the cost of transportation on railways was mostly three times greater than on canals. Boats carrying 210 tons burden are now used on the Erie Canal, the enlarged locks being eighteen feet wide and 210 feet long between the quoins. The boats are mostly moved by animal power, at a cost of thirty-eight cents each per mile, except on the river and lakes where they are taken in tow by steamboats. The average speed of canal boats of the largest class moved by horses does not exceed two miles an hour, and as only three horses can be employed with advantage to each boat, it follows that any further increase on the size of canal boats would involve a corresponding decrease in speed when moved by animal power. According to the able report for 1858 by the Hon. Van R. Richmond, New York State Engineer and Surveyor, the resistance to be overcome in moving a loaded canal boat at a speed of two miles per hour, calculated from Dubuat's formula, as modified by D'Aubisson, is 428 pounds. The force required to develop the standard value of a horse-power at 2 miles per hour is 187½ pounds; deducting one-sixth for oblique action, leaves the force exerted in the direction of the boat's motion equal to 156¼ pounds. From experiments made in France in towing barges on the Lanquedoc Canal, it was found that ordinary horses exerted an average effort of 143½ pounds for six consecutive days, at a speed of two miles per hour. Consequently an Erie Canal boat, which partakes of the general build of the Lanquedoc barges, would require three horses to move it at the rate of two miles per hour. The resistance of a vessel varies as the square of its speed, and the power to move it varies as to the cube of its speed. This law seems to have been overlooked by some of those who have attempted to move canal boats at comparatively high speed by means of steam power. They have recognized the truth of only a part of the proposition, namely, that the resistance varies at the square of the speed, that is to say, if a boat requires eight horses to overcome the resistance at four miles an hour, to double its speed would require four times eight or thirty-two horses; yet it is evident that this power must be applied while the boat is moving double the distance first made, therefore the number 32 must be doubled, which gives 64 horses as the measure of power required to move the boat at the rate of eight miles per hour. This law, however, cannot be strictly true for all forms of vessels, and in navigating canals there are other conditions which modify the the result, as for instance, the wave of displacement which rising high in shallow water would seriously impede a vessel, but were its form so improved as to allow the water to commence closing in when only one-third of her length had passed, and were its speed at the same time increased to a certain point, this wave of displacement would be brought into such relative position that it would no longer impede the vessel. However, the carrying capacity of a canal boat being paramount, its form must not be modified so as to favor increased speed; thus with this class of vessels the law will still hold good, to double the velocity the propelling power must be increased eight fold. If a loaded canal boat is moved at the rate of two miles an hour with three horses and at the rate of four miles an hour with twenty-four, the obvious deduction is that it is impracticable to move such boats by horse haulage at the rate of three miles per hour, and quite as impracticable to move them by steam power at a speed greater than four miles an hour.

The plan of moving several canal boats by one steam tug is objectionable, because the whole moving power is concentrated at one place, and acts upon a very limited quantity of water. The same power divided into four equal amounts, and acting on four times the quantity of water would be more effective. Such boats are most liable to delays and are utterly helpless when detached from the steam tug.

The successful navigation of canals seems to me to depend on the following conditions:

1. Each boat should be automatic, that is to say, self-propelling.

2. The build of the boat should be such as to give it the greatest carrying capacity.

3. To economize space and power, the boiler and engine should be small and capable of moving the boat when loaded at an average speed of three miles an hour. This rate is about double the present average of loaded boats.

4. The propelling power should act directly against the water and not against the bottom or sides of the canal.

5. If we turn to nature for lessons in propelling, we observe that the slow moving fish of our fresh water streams have broad tails bounded by nearly a vertical line, while those remarkable for speed have V shaped tails, the extremities of which are capable of very quick motion. Applying this principle to slow moving boats we infer that a quick motion is not so essential as a large average of propelling surface.

6. The width of the boat and its draft should only limit the quantity of water against which the propelling surface should act.

7. The boat should be made more obedient to the helm, by enlarging the rudder surfaces and arranging them so as to act on shallow water more efficiently than by the common method. The most important of these conditions would be fulfilled by building the boat with four sterns, and placing behind each a propeller; or giving the boat a scow-shaped stern, and arranging in one line behind it four screw propellers, placed nearly as deep as the water at the bottom of the boat, from which would project iron bars for their protection. The locks being eighteen feet wide, the propeller blades could be nearly four feet six inches in diameter, and whether the boat was light or loaded, these propellers would act on the water under the best possible conditions. Behind each of these propellers should be placed a balanced rudder, which, under these conditions, could be made one-fourth lighter than usual, and the tiller of each should be connected by a moveable joint, with one bar extending nearly across the boat, behind which the steersman can guide the boat by only exerting strength sufficient to overcome the friction of the apparatus. A boat embracing the improvements here suggested has not yet been constructed; but from careful estimates based on reliable data, I feel warranted in saying that such a boat when loaded could be moved at a speed of three miles an hour, with an expenditure not exceeding that now incurred in towing a similarly loaded boat at the rate of two miles an hour by means of horses. The saving thus effected would be between one and two million dollars per annum on the present business of the canal. A large portion of the carrying trade has been diverted from canals solely on account of the time consumed in transportation; we may reasonably infer that an acceleration of speed of about fifty per cent. would greatly increase the amount of goods transported by these cheap modes of conveyance, and thus correspondingly increase the revenue which the State derives from its canals.

Proportional Compasses.

A foreign journal gives a description of a novel instrument for the workshop. This consists of proportional compasses, which give directly the length of the circumference of any circle, of a moderate diameter. This is a problem which is constantly requiring solution in mechanical operations; as, for instance, when we wish to mark off on a piece of tin the breadth of a strip required to form a cylindrical tube of a given diameter, etc. It is well known, of course, that the diameter, etc., of a circle bears, in round numbers, to the circumference the ratio of 1 to 3.1416; and the construction of the compass is, therefore, based upon this ratio. All that is necessary is to have a compass with two pairs of unequal arms, the long arms being exactly 3.1416 greater than the short arms. On applying the points of the short arms to the extremities of the given diameter laid down on the scale, the distance between the points of the long arms will be the required circumference. It is, of course, perfectly practicable to obtain the ratio in question by calculation; but many persons are not skilled in this, and the instrument will enable any one to make a practical application of the law at once. If, for instance, it be desired to construct a tin tube of 3 inches in diameter, the tips of the short arms of the compass are to be separated to this extent, and the distance between the tips of the long arms will give the circumference required, due allowance, of course, being made for the overlaps.

Triangular Drawing-Board.

Mr. George Fawcus, of North Shields, has contrived an equilateral triangular drawing-board for isometrical drawing. An ordinary T square applied on the edges of an equilateral triangle draws tangents that meet each other at angles of 120°, and other lines drawn parallel to these radiating ones form with them angles of 60° and 120°, which are the exact angles of the apparent squares of isometrical cubes. The inventor believes that the use of this new drawing-board will make the teaching of isometrical drawing both simple and easy. The practice of isometrical drawing is strongly urged in the science and art drawing classes.—*Nature.*

—William W. Sadler, Superintendent of International Ocean Telegraph (Cuba line) died of bilious fever at New Haven on the 24th ult. Mr. Sadler had been a telegrapher for twenty-two years. His residence of ate was at Jacksonville, Fla.

Calculation of Excavation and Embankment Tables.

BY WM. GRIFFIN, C. E.

Engineers frequently find themselves, when in the employment of a new company, in want of tables, adapted to such bases and slopes as are not contained in any published tables. The following expeditious and easy method of calculating earth-work tables has been familiar to the writer for more than twenty years, and it is believed is now published for the first time.

As a preliminary to the method, I will take the following equation:

$$y = a x^m + b x^{m-1} + c v^{m-2} \ldots + p x + q,$$

and explain that if we give to x a succession of values, increasing according to an arithmetical progression, the values of y will increase according to a law which is easily ascertained If we give, in the foregoing equation, to x successively the values 0, 1, 2, 3, 4, etc., we shall ascertain the corresponding values of y. Then taking the differences of the values of y, we will obtain the first order of differences, generally designated D^1. Then, taking the differences of the differences, we will obtain the second order, designated D_2. And again, by taking the differences of the second order we obtain a third order, and of the third order a fourth, and so on, until an order is finally arrived at that is constant. If m represents the highest exponent of the equation, then the mth order of differences will be constant. An equation of the fifth power giving five orders; one of the fourth power four orders; a cubic equation three orders, and a quadratic equation two orders.

Upon the above principles, let it be required to calculate an excavation table, for a base of 20 feet, with slopes of three-quarters to one, and for 100 feet lengths. Let y represent the cubical contents in yards, and x the depth of cutting in feet and tenths of feet. Then we shall have this equation:

$$y = \frac{100}{27}(20+\tfrac{3}{4}x)x = \frac{100}{27}(20x+\tfrac{3}{4}x^2) = 3.703\ (20x+\tfrac{3}{4}x^2)$$
$$= 74.074x + 2.777x^2.$$

Now give to x a regular succession of values, as 0, 1, 2, 3, etc., and we will have

For $x = 0$, $y = 0$.
For $x = 1$, $y = 76.851,851$.
For $x = 2$, $y = 159.259,259$.
For $x = 3$, $y = 247.222,222$.
For $x = 4$, $y = 340.740,740$.

Take the differences of these values of y and the differences of the differences, and we will have:

	D_1	D_2
	76.851,851	
		5.555,555.
	82.407,407	
		5.555,555.
	87.962,962	
		5.555,555.
	93.518,518	

We now rule four columns, designated respectively x, y, D_1 and D_2, and having inserted the figures already ascertained, we will add the figures in column D_2 to the previous ones in column D_1 and then those in column D_1 to the previous ones in column y, and will thus ascertain the value of y, for the corresponding value of x, or the cubical contents, for the particular depth.

x	y	D_1	D_2
0	0	76.851,851,851	
1	76.851,851,851	82.407,407,407	5.555,555,555
2	159.259,259,259	87.962,962,962	5.555,555,555
3	247.222,222,222	93.518,518,518	
4	340.740,740,740	99.074,074,074	
5	439.814,814,814	104.629,629,629	
6	544.444,444,444	110.185,185,185	
7	654.629,629,629	115.740,740,740	
8	770.370,370,370	121.296,296,296	
9	891.666,666,666	126.851,851,851	
10	1018.518,518,518	132.40 ,407,407	
11	1150.925,925,925	137.962,962,962	
12	1288.888,888,888	143.518,518,518	
13	1432.407,407,407		

In this way we can continue the table to any depth that may be required. If we notice the figures of the decimals in column D_1, we shall see that they are repeated for every ninth foot. This is as it should be, for 5.555 multiplied by 9 is equal to 50,000. Therefore, after the first ten feet, the calculation is proceeded with with much less trouble and difficulty.

To make the calculation by tenths of feet. First find the orders of differences by substituting for x, in the foregoing equation, the values 0, 0.1, 0.2, 0.3, 0.4, and the following results are obtained:

		D_1	D_2
For $x = 0$	$y = 0$.		
For $x = 0.1$	$y = 7.435,185$	7.435,185	0.055,555
For $x = 0.2$	$y = 14.925,925$	7.490,740	0.555,555
For $x = 0.3$	$y = 22.472,222$	7.546,296	
For $x = 0.4$	$y = 30.074,074$	7.601,851	

Four columns are now again ruled, and we then proceed in the same manner as for whole feet.

a	y	D_1	D_2
0	0		
0.1	7.435,185,185	7.435,185,185	0.055,555,555
0.2	14.925,925,925	7.490,740,740	0.555,555,555
0.3	22.472,222,222	7.546,296,296	
0.4	30.074,074,074	7.601,851,851	
0.5	37.731,481,481	7.657,407,407	
0.6	45.444,444,444	7.712,962,962	
0.7	53.212,962,962	7.768,518,518	
0.8	61,037,037,037	7.824,074,074	
0.9	68,916,666,666	7.879,629,629	
1.0	76,851,851,851	7.935,185,185	
1.1	84.842,592,592	7.990,740,740	
1.2	92.888,888,888	8.046,296,296	
1.3	100.990,740,740	8.101,8 1,851	
1.4	109.148,148,148	8.157,407,407	
1.5	117.361,111,111	8.212,962,962	
1.6	125.629,629,629	8.268,518,518	
1.7	133.953,703,708	8.324,074,074	
1.8	142.333,333,333	8.379,629,629	
1.9	150.768,518,518	8.435,185,185	
2.0	159.259,259,259	8.490,740,740	

We observe that the decimals again repeat themselves in column D_1, for every ninth foot.

In calculating earth-work tables, after the method here set forth, the calculations should always be made separately, for the whole feet and tenths of feet. The one will be a check upon the other, and consequently any error in the figuring will be readily detected.

If one should desire to calculate earth-work for final estimates with the same accuracy as by the prismoidal formula, it can be done with the tables calculated as the foregoing, and with much more expedition. It is only necessary to add the cubical contents for each end-depth to four times that of the average end-depth, and then take one-sixth of the sum, and the same result is obtained as the prismoidal formula would give.

Suppose, for instance, that we should desire to know the amount of excavation for a cutting 100 feet long, and one foot deep at one end and nine feet at the other.

The foregoing table gives:—

For 1 ft.	76.853 cu. yards.
For 9 ft.	891.666 "
For 5 ft. 439.814 c. yds., which multiplied by 4=.	1,759.259 "
Amount.	2,727.777 "

One-sixth of which is 454.629 cubic yards; exactly the same result as given by the Prismoidal Formula.

For approximate estimates we can merely average the cubical contents for each end depth, or take the cubical contents for the average depth—the former giving too much and the latter too little.

Take the last amount again.

The Prismoidal Formula gives	454.629 cu. yards.
The average depths give	439.814 "
The average cubical contents give	484.259 "

The average depth giving 24.814 yards too little, and the average contents 44.444 yards too much.

In order to show that the law of the differences holds good, for cubic equations, as well as for quadrature, I will take the following:

$$y = x^3 + 2x^2 + 3x + 4$$

Now give to x, in succession the several values, 0, 1, 2, 3, etc., and arrange a table as before.

x	y	D_1	D_2	D_3
0	4	6	10	
1	10	16	16	6
2	26	32	22	6
3	58	54	28	
4	112	82	34	
5	194	116	40	
6	310	156	46	
7	466	202	52	
8	668	254	58	
9	922	312	64	
10	1234	376	70	
11	1610	446	76	
12	2056	522	82	
13	2578	604	88	
14	3182	692		
15	3874			

—Van Nostrand's Engineering Magazine.

The Artisan in Prussia.

Compulsory education being the rule in Fatherland, the German artisan has that much in his favor; yet his English brother would not care to change places; low wages and meager diet sadly counterbalancing a little extra culture. $3.00 a week is very good pay in Prussia, as determined from a long list of weekly wages in that country in 1867. In most cases twelve hours, and in many, thirteen, go to the working day. Women form more than a fifth of the factory operatives, and earn, comparatively, good wages; but public labor brings its too frequent consequences, and the female operatives bear a very indifferent character. As for seamstresses and milliners, those who work for commercial houses are, as usual, most miserably paid; so miserably, indeed, that to live at all they are compelled to eschew morality.

The wages quoted above are said to suffice thrifty men while single, and even leave a margin for saving; but to keep a family upon them, unless the mother at least can contribute something towards the income, is out of the question; and those who know most about the matter do not set the cost of a family at a very extravagant rate. According to official calculations, a man with a wife and three or four children can provide food enough for all at an annual expense of $60.00 if he lives in the province of Prussia; in Posen it would take more than double the amount; while in Pomerania it may be done for a little less. Certainly the Prussian dietary standard is not a very high one, bread, vegetables, butter, and milk being all that is considered necessary; meat, except, perhaps, on holidays and Sundays, coming in the category of luxuries. The daily fare of a workman in the Rhenish provinces is set down as consisting of one pound of rye bread, two pounds of potatoes, an ounce of meat, half an ounce of salt, and one sixth of an ounce of coffee.

Nor can the Prussian be said to be much better off as concerns his lodgment; high rents, confined spaces, little comfort and less cleanliness being the rule throughout the kingdom. In the large towns, with very rare exceptions, artisans live in lodgings; several families herd together—sometimes as many as fifteen individuals crowding into one small, low, damp room—twenty-five cents a week a head being the Berlin tariff for sleeping accommodation and convenience for washing. Three years since the returns showed there were in the capital 15,574 dwellings, with an average of six to seven occupants per room. In the country and in the small towns—unless lodgings are provided by the employer—working folks generally have a house of their own: a house, such as it is. In Memel it will be a mere mud cabin with nailed-up windows; in Silesia, a one-storied thatched house, with diminutive windows, and rooms just high enough to allow the proprietors to stand upright in them. The miners of the circle of Ottweiler, in the Rhine province, are perhaps the best off in this respect, being looked after by the Government itself. "The Rheden mine has two of these for the accommodation of 400 men. The miners pay thirty-six cents a month, for which they have a bed and towels, and the use of half a press. To enable miners to settle in the neighborhood, the Miners' Union has purchased 1,350 acres of land for founding a mining colony. It sells at cost price, or leases at a moderate rent, one-sixth of an acre of land to any one who will build a house upon it, and one-sixth of an acre upon the same terms for a garden. Money for building purposes is also advanced at four per cent. interest, to be deducted from the wages, with a present of from $100 to $120 as a premium for building." These houses at Ottweiler are, as might be expected, neat and cheerful; but, with the exception of them, the description "bad, small and densely crowded" applies generally to the habitations of the Prussian workman, in whatever part of the land he may be domiciled.

A better condition of things might be looked for where such pains are taken to render the laborer worthy of his hire. Primary education is obligatory for all children from the age of six to that of fourteen, and afterwards the journeyman or apprentice may continue educating himself at the "Fortbildungsschulen," open Sundays, and occasionally upon week days, for a somewhat higher degree of instruction. When a Prussian lad has recived the education prescribed by law he chooses his trade, and binds himself to a master, who, for his labor, gives him board, lodging and instruction. Apprenticeship seldom lasts more than three years, at the end of which time the young workman gets a certificate from his master, and sets out upon his travels—"wandering," as it is called, being reckoned necessary ere he can claim admittance into the ranks of journeymen. He usually makes a point of visiting the places specially famed for excellence in his branch of trade. If he be a stone-cutter, he must not miss Munich and Cologne; if a locksmith, Berlin and Vienna; if a tailor, Dresden must become his residence for a while; if no one wants his services at any town he enters, the Journeyman's Fund there supplies him with the means of taking him elsewhere. The more ambitious artisans are not satisfied with tramping through Germany, but betake themselves to foreign lands, where not a few of them are tempted to remain—and no wonder! Traveling about the world with open eyes cannot but do the travelers good, and the practice is therefore to be commended; it is, however, doomed; the new Industrial Code of the North German Confederation has pronounced against it, by declaring wandering no longer compulsory, and that traveling handicraftsmen have no claim for assistance upon their associates in the trade. The Code only came into operation in October, 1869, so that what effect its provisions will have cannot yet be seen. By it a variety of restrictions upon the freedom of industry were swept away; all engagements between man and master are declared to be matters for mutual agreement, to be canceled by a fortnight's notice on either side; and the old prohibitions against workmen uniting, for the purpose of obtaining more favorable wages and conditions of work, more especially by means of strikes, are repealed. But, at the same time, "any one inducing, or seeking to induce, others, by physical force, threats, or outrages, or by placing them under an interdict, to take part in these coalitions," was made punishable by three months' imprisonment. Nevertheless, in Prussia, as elsewhere, labor and capital are continually wasting their resources in trying each other's strength and obstancy.—*Chambers' Journal.*

Railroad Depot and Bridge Coating.

An outside coating for rough brickwalls which at the same time prevents moisture from penetrating through, which is in use by the United States Government for painting its light-houses, has recently been applied in several places in this city. It is said to be a good waterproof as well as an excellent substitute for paint for outside walls: Take of fresh Rosendale cement three parts, and of clean, fine sand one part; mix with fresh water thoroughly. This gives a gray or granite color, dark or light, according to the color of the cement. If brick color is desired, add enough Venetian red to the mixture to produce the color. If a very light color is desired, lime may be used with the cement and sand. Care must be taken to have all of the ingredients well mixed together. In applying the wash, the wall must be wet with clean fresh water, then follow immediately with the cement wash. This prevents the bricks from absorbing the water from the wash too rapidly and gives time for the cement to set. The wash must be well stirred during the application. The admixture to be made as thick as can be applied conveniently with a whitewash brush. We are assured by those who have used it, that this cement wash will stand for years, that it is admirably suited for brickwork, fences, etc., that it is nearly water-proof, but that it can not be used to advantage over paint or whitewash.—*National Car Builder.*

—The Springfield *Republican* mentions that nine hundred cars passed east of Pittsfield lately the first two days of one week, and full as many passed east of Springfield. This activity in the freight service keeps busy all concerned; in the busy period referred to one of the engineers had found time to sleep only six hours out of sixty.

—It is said that a box-car of a train on the Sullivan Railroad at Windsor, Vt., for Boston, was opened recently, in which was crowded one hundred and twenty-five lambs—out of that number only four were alive—one hundred and twenty-one had been smothered to death by the extreme heat.

—The new elevator of the Milwaukee & St. Paul Railway Company, at La Crosse, has capacity to store 125,000 bushels of grain and to transfer from barge to car 5,000 bushels per hour. It has a 100-horse-power engine.

General Railroad News.

OLD AND NEW ROADS.

Portland & Ogdensburg.

Snow's Pathfinders' Guide says that there seems to be no doubt but this road will run through the notch at no distant day. The Maine section is already well advanced toward completion, and the Vermont section is under contract. The exact route through the notch has not yet been determined upon. Three different surveys have been made, and one which follows the side of Mount Webster is said to bring the grade down to only sixty-five feet to the mile.

Belfast & Moosehead Lake.

It is said that 300 men are working on this road night and day, in order that it may be completed before the first of November, as the Maine Central may otherwise take advantage of a lapse of the contract and refuse to pay $48,000 per year for the lease of the road.

St. Paul & Sioux City.

The Mankato *Review* understands that the St. Paul & Sioux City Company have in contemplation the extension of their road from a point of junction at the Welsh school house in South Bend township, *via* Garden City, Vernon and Shelby to Blue Earth City, and thence southerly to connect with some road from Iowa. The success of this road is contingent upon the possibility of making a connection with an Iowa road penetrating the coal fields of that State, and also liberal local aid from the towns benefited—$80,000 being the estimate for Blue Earth county, and apportioned $20,000 to Mankato, $30,000 to Garden City, and $15,000 each to the townships of Vermont and Shelby. Faribault county is expected to contribute $100,000 in bonds to this enterprise.

Canada Southern.

A preliminary survey of the line has been completed, and seventy miles are located. Liberal aid has been voted by some counties on the line.

"Bee Line."

Cars now run through from Louisville and from St. Louis to Cleveland, by this line. For St. Louis the line consists of the Cleveland, Columbus, Cincinnati & Indianapolis, and the Indianapolis & St. Louis roads; for Louisville, the road first named and the Jeffersonville, Madison & Indianapolis.

Carthage & Quincy.

The grading, bridging and tieing of this road, between Carthage & Quincy, is completed with the exception of the bridge over Bear Creek. Tracklaying was begun last week.

Peoria & Wenona.

The Secretary writes to us that this company was organized at Lacon, Ill., on the 16th ult., with the following directors: Silas Ramsey, Chas. H. Deane, J. B. Carrigus, E. W. Quincy, Dav. K. Smith, E. H. Baldwin, G. L. Fort.

Silas Ramsey, of Lacon, was chosen President; Charles H. Deane, of Peoria, Secretary; and J. B. Garrigus, Treasurer. The route of the proposed road is from Wenona westward to Lacon, 20 miles, where it is to cross the Illinois River by a bridge authorized by the charter. Thence the route is southwestward about ten miles to Lawn Ridge, and thence due south about twenty miles to Peoria. The charter authorizes the company to make the bridge at Lacon a toll bridge. The Secretary writes that the company has a grade ready for use from Wenona and Lacon, and that work will be commenced on the route very soon. Such a road would connect with the Chicago & Alton for Chicago, and the Illinois Central for Dubuque and the Northwest.

Hannibal & St. Joseph.

The company's shops have recently completed two very elegant coaches for the Pullman Palace Car Company, to be run on the line of the Hannibal & St. Joseph road. They are called the "Hannibal" and the "Cameron." They made their first trip as a part of the excursion train over the Kansas Pacific Railway. These coaches have Mansett wooden wheels with steel tires, Ruttan's ventilators, Miller's life-saving platforms, and Baker's heaters, and are pretty good examples of the latest improvements in car building.

Mr. Edward Wilder, the Land Commissioner, writes to us that during the month of August sales of the company's lands were made to thirty-seven purchasers, amounting to 1,716 acres and six town lots, for $21,620, or at an average price of $12.60 per acre.

Canada Central.

This company has now nearly completed a section about 30 miles long from Ottawa, the capital of the Dominion, southwest to Carleton Place, a station on the Brockville & Ottawa Railway, 47 miles north of Brockville. (The Brockville & Ottawa road extends from Brockville to the Ottawa River about forty miles west of the city of Ottawa). It is intended to continue the line down the Ottawa to make a direct line to Montreal, and also northwestward to Pembroke, on the Ottawa 65 miles northwest of Carleton Place.

Evansville, Carmi & Paducah.

Ground was broken on this line at Evansville on the 6th inst.

St. Paul & Chicago.

The work of laying the iron between Hastings and Red Wing was begun last week and is proceeding at a rapid rate. The grading is all completed and nearly all the iron necessary, received at Hastings. The ties and other material are all on the ground, and it is expected that the road will be completed and the cars running thereon by the first of October next.

Winona & St. Peter.

It is proposed to build a branch of this road from Mankato south to Blue Earth City, which is 36 miles further south.

The company has at last decided to bridge the Minnesota River at St. Peter which enables it to run trains into the town. Its cost will be about $100,000. St. Peter subscribes $25,000, and gives the right of way and fifteen acres of land for depot grounds.

Pacific Railroad of Missouri.

Under date of the 1st inst. the General Freight Agent, W. D. Lewis, has issued the following circular:

"This road has now completed its extension to the Mississippi River, and perfected its ferry and transfer arrangements. Cars are being transferred, and we are prepared to receive and transport, without breaking bulk at St. Louis, all freight coming to us from the Eastern lines, destined to points reached by our own road and its Western connections.

"We expect that all the landings on the east side of the river will be immediately provided, so as to put us in direct connection with all the Eastern lines running into St. Louis, and enable us to do a through business between the East and the West without breaking bulk.

"We shall be glad to receive a share of your business, and will take every pains to see that freight is transported promptly."

The importance of this improvement can hardly be exaggerated. The breaking of bulk at St. Louis has been one of the chief obstacles, perhaps *the* chief, to heavy through shipments between the East and Missouri and Kansas.

Lafayette, Bloomington & Mississippi.

The work of grading this road progresses quite rapidly and it is expected that the part between Bloomington and the State line will be graded and bridged by the 15th inst. Between Lafayette, Indiana, and the State line the road is graded and bridged, except about four and a half miles. This short distance includes a bridge across the Wabash. This bridge is to have five piers, of which four are done. This is also to be finished by the 15th.

The division between Lafayette and Muncie has as yet had nothing done upon it. The necessary subscriptions have all been voted, but some parties are disposed to test the validity of the subscriptions, a decision upon which will be had the latter part of October, and until that time nothing can be done.

The Western Division from Bloomington to Quincy has received subscriptions amounting to $350,000 as follows:

Quincy City	$10[illegible],000
Benton, Adams county	15,000
Columbus, "	25,000
Clayton,	30,000
Rushville, Schuyler county	40,000
Beuna Vista, "	30,000
Astoria, Fulton county	10,000
Woodland, "	15,000
Havana, Mason county	40,000
Pennsylvania, "	10,000
Allen's Grove, "	25,000
Prairie Creek, Logan county	10,000

These subscriptions are from the townships between San Jose (a station on the Jacksonville road) and Quincy. It is proposed to use the Jacksonville road from Bloomington to San Jose.

McGregor & Missouri River.

This, the great Iowa line of the Milwaukee & St. Paul Company, is completed to Algona, which is due north of and forty miles distant from Fort Dodge, and 175 miles west of McGregor. Less than 120 miles more will complete it to the Dakota line, which, doubtless, it will cross eventually. This road is from twenty-five to thirty miles south of the Minnesota line.

Lexington & St. Louis.

This company is constructing a railroad from Sedalia, on the Missouri Pacific, northwest to Lexington, on the Missouri River, a distance of 58 miles. For some time the grading has been nearly completed and now the company has nearly iron enough for the track. Last week the directors of the Missouri Pacific voted to take up the bonds of the Lexington Company, in order to enable it to complete the line soon.

St. Joseph & Denver.

The directors met at St. Joseph on the 1st of September and made final arrangements for the construction of the western division of the road, Marysville to Fort Kearney, 150 miles. The contract was made with Messrs. A. M. Saxton, A. Beattie, Abram Nave, Dudley M. Steele, and R. E. Turner, to build the road from Marysville to Fort Kearney, within eighteen months after its completion to the former place, and also to put on the necessary rolling stock, in consideration of $2,500,000 in stock and $5,500,000 in bonds of the company, the latter to be secured by lien on the 1,700,000 acres of land donated to the company by act of Congress in 1866. The contractors also agreed to furnish money to pay off the floating debt of the company, and to advance $150,000 to complete the eastern division, Marysville to St. Joseph, 110 miles.

This, while nominally a contract for building, is virtually a sale of the road to the contracting parties, as the issue of $2,500,000 of stock gives them a complete controlling interest.

About seventy miles of the eastern division is now completed and the grading is finished nearly to Marysville. The contract for grading the first fifty miles west of Marysville has been let.

Burlington & Missouri River of Nebraska.

A line of stages runs in connection with this road from Lincoln southwestward twenty miles to the Big Blue River, to which point the railroad will be extended.

St. Paul to Chicago.

The Winona *Republican* says that "Negotiations are now pending, it is understood, for establishing a new eastern outlet for travel and freights to and from St. Paul *via* the St. Paul & Sioux City to Wardlaw's ravine, thence by Winona and the Eastern Connection to Milwaukee and Chicago. This route is to be established by the Chicago & Northwestern Company, in opposition to the Milwaukee & St. Paul Company, between whom a good deal of rivalry exists." But the *Republican* neglects to show how traffic can go from La Crosse to Chicago or Milwaukee without passing over the Milwaukee & St. Paul road That can be done only when the Chicago & Northwestern has completed its Madison and La Crosse line, and by that time the direct river route from Winona to St. Paul will be completed.

Western of Alabama.

This company owns the new short line between Selma and Montgomery, and it has just purchased the Montgomery & West Point road, which extends from Montgomery northeast to the Georgia line, and in connection with the Atlanta & West Point road, forms a line to Atlanta and the north and northeast. It has also a connection to Columbus and Savannah, and other Southern coast cities.

Mississippi, Ouachita & Red River.

Nearly one hundred miles of the road is already graded and forty miles are now in running order. From Eunice it will run to Camden, Ark., and thence to Shreveport and will be completed clear through in about seventy days. Within the past ten days over two thousand men have been forwarded from St. Louis to work on this road. Col. J. E. Sickles, Chief Engineer, and Col. Ryan, Purchasing Agent, were in St. Louis last week purchasing a large amount of supplies for the company, including several locomotives.

Monadnock Railroad.

This railroad will be completed from Winchendon, a station on the Cheshire Railroad a few miles south of the New Hampshire-line, northeast to Peterboro, N. H., by the 1st of October. It is intended next year to complete it to the southwestern terminus of the Contoocook Railroad, making a direct connection with Concord, and in connection with the new Athol & Enfield Railroad in Massachusetts, giving that place a direct line to New York through a country now destitute of railroads.

Holly, Wayne & Monroe.

This road for sometime has appeared to be in a morbid condition although a large part of the line is graded. But recently the Flint & Pere Marquette Company has made a proposition to iron, equip and operate the road, if the Holly, Wayne & Monroe Company will raise $100,000 at once. The latter company has accepted the proposition and is now trying to raise the amount, which is apportioned among the towns along the line. With such a connection the Flint and Pere Marquette road would give Detroit the go-by and make Toledo its virtual terminus. This would give Toledo a hold upon Eastern and Northern Michigan such as it might never obtain otherwise.

St. Louis & St. Joseph.

The arrangement by which this road was to pass under the management of the North Missouri Company went into effect on the 1st inst., when through tickets over the new line were supplied to the company's agents. Pullman palace and drawing-room cars are features of the new route.

Kansas City, St. Joseph & Council Bluffs.

The St. Joseph *Gazette* gives the following details of the proposed new St. Joseph depot. The plans were

proposed by Mr. H. W. Lewis, Assistant Engineer of the company:

"The main building is to be of brick, 100 by 24 feet, with a baggage room at each end. The ticket office is located in the centre, with the ladies' room on one side and the gentlemen's room on the other. A refreshment room is also located in one end of the building. The structure, it is estimated, will cost some $60,000.

The Buffalo Bridge.

We have before been indebted to the Buffalo *Commercial Advertiser* for information concerning the progress of this work. According to this authority, the sub-contract of the woodwork has been let to Mr. Henry McFarland, and that of masonry to Mr. McCaul. Captain James Haggart has charge of the tug work, and has in use the powerful little steamer C. W. Jones. Woodshops have been erected, docks obtained for the storage of stone and other materials used, and excellent provision made for all matters necessary to insure rapid progress. The offices of the builders will be found at the Exchange Hotel and Wallace House, Mr. A. W. Schweigert, who is the chief agent at Fort Erie of Messrs. Gzowski & Co., having taken up his quarters at the former place.

The wrought iron superstructure is being made at Phœnixville, Pa., and this part of the work is, we believe, in charge of Messrs. Kellogg, Clarke & Co.

The stone is brought from Georgetown, Canada, a station on the Grand Trunk Railway, distant 160 miles from Fort Erie, and is in readiness on arrival for immediate use.

The first caisson has already been sunk on the Canada side of the river, and an idea of the durability of the work may be gathered from the method used. At the bottom of the caisson there is first laid five feet of concrete, which becomes in a short time as solid as a rock. Above this comes the masonry, the stone blocks used weighing nearly two tons each. The second caisson is now completed, and was to be sunk last week, the time of sinking it of course depending on the weather. The distance between the first caisson and the second will be one hundred and ninety feet. The second abutment will have a foundation of eleven feet of concrete, the second caisson being sunk in seventeen feet of water. The third caisson will be sunk in twenty-seven feet of water, and the fourth in thirty-eight feet.

On the American side pile driving is in progress. On Squaw Island, after penetrating through six feet of marshy loam, a gravel bed is reached. According to the terms of the contract the bridge was to be completed for railroad and carriage traffic and for foot passengers before the close of the year 1871.

Peoria & Rock Island.

The entire line, which was mostly graded last year, is now nearly ready for the track, and iron is on the way for thirty miles of track, which is to be laid during the present month. It is to be laid at both ends of the line at once. From Rock Island southeast to Orion, twenty miles, the track will be used by the Rockford, Rock Island & St. Louis Company to enter Rock Island from the south.

Des Moines & Ames.

Ames township, which is on the Chicago & Northwestern's Omaha line due north of Des Moines, has voted a tax of 5 per cent. to aid in the construction of a railroad from Des Moines to Ames. The line was partly graded more than a year ago, and it is said that the aid now voted secures its completion within a year.

Burlington, Cedar Rapids & Minnesota.

Contracts have been made for iron enough to complete the road from Burlington to Cedar Falls, which is to be done by December, when there will be a direct all rail line from Burlington to St. Paul.

St. Joseph & Iowa.

Preliminary surveys have been made for a road of this name, which its projectors hope to build from St. Joseph northwestward through Rochester to Albany, the county seat of Gentry county, about 50 miles.

Marshall & Coldwater.

A correspondent at Coldwater, Mich., writes to us as follows:

"The Marshall & Coldwater Railroad Company was organized at Marshall on the 3d inst., by the election of the following Board of Directors: A. L. Green, of Olivet; F. V. Smith, J. G. Parkhurst, and H. C. Lewis, of Coldwater; M. V. Wagner, H. J. Perrin, Geo. Ingersoll, C. S. Crane, C. P. Dibble, P. A. Spicer, of Marshall, and L. J. Fisk, of Allegan. The Stock Commissioners are Justin Sawyer, J. G. Parkhurst, M. V. Wagner, Geo. Ingersoll, and P. A. Spicer.

"At a meeting of the Board of Directors A. L. Green was elected President; George Ingersoll, Secretary; C. P. Dibble, Treasurer, and D. B. Dennis, Assistant Treasurer. The length of the road is twenty-five miles with a capital stock of $200,000. Mr. Green is President of the road known as the Jonesville, Marshall & Grand River Railroad and this new organization is to take the place of the southern division of the last mentioned road. It will connect at Coldwater with the Lake Shore & Michigan Southern Railway and also with the Mansfield, Coldwater & Lake Michigan Railway, and the division from Jonesville to Marshall will be abandoned. The work on this road will be commenced in October and pushed forward with energy, expecting to lay the track by the 1st of July next."

Mansfield, Coldwater & Lake Michigan.

In Mansfield the subscriptions to this projected line amounted to $125,000 last Wednesday, and a strong effort was to be made to obtain $75,000 more before Friday night.

Delaware, Lackawanna & Western.

The telegraph announces that the difficulty between this company and the Erie relative to the use of the Bergen tunnel by the former company, is amicably adjusted. The $1,000,000 of back tolls claimed by the Erie Company are to be set aside.

Chicago, Danville & Vincennes.

The grading is completed from the present terminus at Momence, 53 miles south of Chicago, for ten miles, to St. Anne's, and it is intended to have the line ready for the iron as far as Watseka, on the Toledo, Peoria & Warsaw Railway, by the 1st of October, and eleven miles further to Milford, in another month.

MECHANICS AND ENGINEERING.

Street Car "Man Catcher."

Mr. U. B. Vidal, of Philadelphia, proposes to provide the street-cars with strong skirts or nets, supported on frames to extend from the flooring down to or near the ground. The object of the improvement is to save persons who fall from being run over by the car. The frame which supports the net is to be elastic, vertically, so as to yield when any portion touches the ground.

Adjustable Car Seats.

A year ago or more we described a New Orleans invention made by a Mr. Blood for changing the position of the backs of car seats. By this the back could be made high or low, and changed from the ordinary position to an angle of 45 degrees or the horizontal position in an instant. When horizontal they form with the seats a continuous cushioned platform, which serves as a bed or lounge. The Hannibal & St. Joseph Company had then made arrangements to introduce these seats on its cars. We now learn that two elegant Pullman day coaches with these seats have lately been completed at the Hannibal shops to be run on this road. A whole seat is sold for a dollar. They are likely to become popular for night as well as day travel, and especially to parties traveling with small children who need to lie down during the day.

A Suspended Tunnel in the Bosphorus.

The enormous traffic from the Stamboul to the Galata and Pera side of the Bosphorus, a continuous stream from morning to night, interrupted only by the vexations and delays caused by repeated openings and shuttings of the bridges of boats which constitute the connecting line of the two shores, must be considered as a sure indication of the utility and necessity of an uninterrupted communication between the two banks.

A tramway company of ample means has lately started with the intention of transporting both passengers and goods on their various lines, both constructed and constructing on either side of the Bosphorus; but little real profit can be expected to be made till the lines on either side are connected together.

The existing bridges of boats are barely large enough for passengers, so that permission cannot be obtained by the company to lay down their rails theron, besides which the constant interruptions would be highly prejudicial. The enormous depths of the water, the precipitous banks, and the well known twenty or thirty feet of mud which forms the bottom, quite forbid the idea of tunneling in the ordinary way, it being impossible to get down low enough, even with the stiffest gradients. One of the chief engineers of the Turkish Government (Mr. Hadden) has therefore suggested a very simple yet effective mode of overcoming these difficulties.

He proposes to suspend or float a tunnel, at about 35 feet below the surface of the water, allowing uninterrupted passage to vessels of the largest tonnage. There is no tide in the Golden Horn. The tunnel would consist of a wrought iron tube, about 10 feet in diameter, and 1,200 feet long; the tube to be cellular, and each cell perfectly independent, or the tube may be lined with wood. The gradient at either end would be one in fifty.

The tube will weigh about 600 tons; maximum weight of any train 400 tons; concrete and lining, to overcome the buoyancy of the tube, 1,700 tons; water displacement, 2,700 tons.

It will be readily seen that when the tunnel is unused there will be a buoyancy or upward strain of 400 tons, which is to be neutralised by holding down chains, which will act precisely like inverted piers or supports. When a train traverses the tunnel, if of less weight than 400 tons, it is evident that no deflection can take place; and on the train leaving the tunnel the chains prevent the reaction of upward deflection which would without their holding down power naturally ensue. In the drawing the tunnel is represented as held down at only *three* points, but any number may be used. It is proposed to name the tunnel "Daoud," after the present talented Minister of Public Works, Daoud Pacha.—*The Engineer.*

The American Fairlie.

The double-headed Fairlie locomotive which was built recently at Taunton, by Mason, drew from Worcester, the other day, forty freight cars, half of which were loaded. It would have drawn more had not the pump given out—a defect easily remedied. This dual engine has one boiler with two heads, and at each end rests on six driving wheels. The water tanks and bunkers for coal are above the boiler on each side of the cab. In going one direction one-half of the locomotive is going ahead and the other backing, and the latter goes ahead when the steam is reversed, and the other half backs. Thus the necessity of turntables is avoided, and it is claimed the same amount of steam in such an engine will accomplish more than in one of the ordinary kind.

A Canadian Wooden Railroad.

A railway which cost only $6,000 per mile, including right of way, grading, track and rolling stock complete, is certainly a novelty. That is the cost of the Quebec & Gosford wooden railway, if the statement of the President is to be accepted. This road is 25 miles long, gauge 4 feet 8½ inches, being the width of most of the American and English railways, speed 20 to 30 miles an hour, length of rail 14 feet, depth 7 inches, thickness 4 inches. Each rail rests on seven sleepers, to which it is fastened by wedges so that it can be easily taken up at any time. The locomotive now used on the Quebec & Gosford Railway weighs 21 tons, loaded, without the tender. This road will be completed in October and ready for traffic. It is very satisfactory to know that there is an immediate prospect that wooden railways will be practically tested in Canada; should they prove to be so well adapted as it is believed they are, to accommodate new districts where the traffic is limited, they will come into large demand to act as feeders to the iron roads.—*Canadian Monetary Times.*

Railroad Manufactures.

It is said that Captain E. B. Ward intends to erect Bessemer steel works, in connection with his iron works at Bay River, early next season.

All the locomotive works at Paterson, N. J., are full of work.

The Mason Works, at Taunton, are building ten heavy locomotives for the Lehigh Valley road. They are to have ten four feet wheels, with cylinders 17x24, and fire boxes 94½ inches long. They are for heavy coal trains.

The Portland Rolling Mills made, during the past year, 13,050 tons finished rails, consuming 4,900 tons pig iron, 11,000 tons old rails and 12,000 tons of coal.

The Taunton Car Company is building six palace cars for Pullman, who seems to have work at almost every good shop in the country.

The Wason Car Company is building 300 box cars for the Rutland & Burlington road.

The Mason Works at Taunton, Mass., are building ten locomotives for the Milwaukee & St. Paul road. They have 5-feet drivers, 16 by 25 cylinders, and weigh 30 tons each. The same works have nearly completed five engines for the Toledo, Wabash & Western.

The Taunton Car Company is building 20 passenger cars, 100 box cars and 50 platform cars for the New Jersey Southern road.

The Osgood Bradley Car Works of Worcester, Mass., have completed two fine passenger cars for the new Portland & Ogdensburg Railroad.

A Travelers' Theodolite.

L. Casella, of London, is manufacturing a small transit theodolite, which is contained in a box 4 by 5 by 6¾ inches, outside measurement. It has a telescope, complete three inch horizontal and vertical circles with verniers reading to one minute, and can be used not only as a theodolite for terrestrial surveying, but also as an altazimuth for determining time, latitude and azimuth astronomically. Its diagonal eye-piece admits of the observation of zenith stars easily. It has a reflector for illuminating the wires at night, a dark glass for solar observations, a finely divided level, a compass and apparatus for all the necessary adjustments. Such an instrument may be very useful to scientific explorers and engineers making preliminary reconnoissances in a new country.

ELECTIONS AND APPOINTMENTS.

—Mr. Andrews, the inventor of the patent swinging bolster, and long in the employ of the Boston & Maine road, has been appointed Master Car Builder of the New York & New Haven road.

—James R. Kendrick, Superintendent of the Concord (N. H.) Railroad, has been offered the superintendency of the New Orleans, Mobile & Chattanooga Railroad, which will soon be in operation between New Orleans and Mobile.

—Addison Day has resigned his position as General Superintendent of the New York & Oswego Midland Railroad and goes into business at Rome, N. Y. He is succeeded by M. P. McKinley, of Oswego.

—William D. Rowley, late Master Mechanic of the Missouri Valley Railroad, has been appointed Master Mechanic of the Central Branch, Union Pacific, with headquarters at Atchison, Ks.

—On the authority of a Chattanooga paper we announced two weeks ago that A. L. Harris had signed his position as Master of Transportation and Supervisor of the Western & Atlantic Railroad, and that Judge J. R. Parrot hod been appointed to succeed him. A correspondent in Atlanta writes to us that this is untrue. Col. Harris has not resigned, and therefore has no successor.

—Mr. Beverly R. Beim has been appointed Assistant General Passenger Agent of the Union Pacific Railroad, the appointment taking effect on the 1st instant. Mr. Beim has been in the service of the company for the past two years, in different capacities.

—At a meeting of stockholders of the Memphis & Raleigh Springs Railroad Company, held at Memphis on the 1st instant, the following directors were elected: E. F. Babcock, E. W. Brooks, C. N. Taylor, A. B. Newkirk, J. T. Swayne, A. J. Kellar, Geo. K. Duncan, H. L. Brinkley, A. J. White.

—Hon. John Cessna has been elected President of the Bedford (Pa.) & Bridgeport Railroad Company. The directors are: Wm. M. Lyon, Henry Loughlin, John Graff, L. T. Watson, G. W. Gump, Wm. M. Hall, Isaac Mengel, David, Wolf, J. W. Lingenfelter, J. R. Durborrow, J. G. Hartley, D. M. Clack.

—The following gentlemen have been elected directors of the Portsmouth & Dover Railroad: John H. Bailey, Daniel Marcy, George L. Treadwell and Frank Jones of Portsmouth, and Amos D. Purington, Joshua G. Hall and Oliver Wyatt of Dover.

TRAFFIC AND EARNINGS.

—The first wheat in bulk, passing over the Lake Superior & Mississippi Railroad, arrived at Duluth on the 26th ult. The train consisted of twelve cars carrying 4,200 bushels. It was purchased by C. T. & E. T. Evans of Buffalo, and was shipped on the Propeller Winslow for Buffalo. This is the first cargo of wheat shipped through the new channel from Minnesota to the East.

—The St. Louis *Republican* says: "The first car load of grain in bulk ever shipped from this city south, by rail, went off on the 1st inst. It was shipped by Marmaduke & Brown to J. M. Clark & Co., Augusta, Georgia, and went over the St. Louis & Iron Mountain Railroad in charge of the Green line. It will go by Belmont, Nashville, Chattanooga and Atlanta to Augusta, without change of car. In consideration of its pioneer character, it was taken free. The experiment promises to be followed by a large business in bulk shipments of grain to the South by rail.

Papers on Iron and Steel.

BY W. MATHIEU WILLIAMS.

I.—A VERY COSTLY AND VEXATIOUS FALLACY.

I.

"A friend of mine has been converting some common cinder pig-iron into either very fine iron or steel by a very simple process, but does not know who to apply to to learn its value. He is willing to share the profits with any one who will help him in the matter. I have some samples of it if you would like to see it, or can tell me who would be likely to interest themselves in the matter. From what I can make out I should think it would make good steel, for it will harden and temper now."

The above quoted from a letter I have recently received, is a typical sample of a number of others I have had at different times, and it represents the labors of quite a multitude of patient, long-suffering and miserably deluded investigators. The published specifications of abandoned patents make painful record of wasted money, time, and ingenuity; and suggest dark tragedies of ruined hopes, all arising from the same misunderstanding of the changes which take place in the conversion of *ordinary* pig-iron or cast-iron into *merchantable* steel.

The most humiliating part of this delusion is that it is not the off-spring of popular ignorance, is not prevalent among the beer-drinking class of iron-workers, who sign their names with a +, but crops out among intelligent men, who have studied the chemistry of iron and steel as expounded and recognized in chemical books. The the costly fallacy I allude to is directly traceable to the teachings of our highest scientific authorities. As Nature is now largely circulating among the class of self-taught and energetic men who supply this ever-recurring crop of victims, and also among those who most unwittingly and unwillingly have deceived them, there can be no better medium through which to effect the demolition of this mischievous error.

By reference to almost any text-book on chemistry, it will be found that cast iron is described as a compound or mixture of iron and carbon; that steel is another compound or mixture of iron and carbon, but with a less proportion of carbon; and that wrought iron is nearly free from carbon. Further we are told that the ordinary method of making steel is, first to remove all the carbon from the cast or pig-iron by making it into wrought or bar-iron, and that this bar-iron is afterwards converted into steel by causing it to take up a new dose of carbon in the cementing furnace. The natural inference of a thinking reader is, that this is a clumsy complication, especially if he knows that the process of cementation is slow and costly, that on account of the irregular diffusion of the carbon in the blistered bars, other expensive processes of shearing, tilting, casting, &c., have to follow. Why not at once produce the steel from cast-iron by a process of decarburisation which shall stop at the right point, *i. e.* when the three or four per cent of carbon of the cast-iron is reduced to the one or one and a half per cent. required to produce steel? By doing this, not only the cost of converting wrought-iron into steel, but also the cost of puddling to produce wrought-iron will be saved; and steel, which is but a carburet of iron intermediate between cast and wrought-iron, instead of being so much dearer than either, should be made at an intermediate cost, or cheaper than wrought-iron.

If he dips further into the literature of the subject, and reads the history of the manufacture of iron, he will find further confirmation of such reasoning, as he will learn thereby that the direct production of steel is an ancient art, and that weapons of renowned quality were made from steel thus produced.

By reference to one of the most recent and elaborate English treatises on the subject, Dr. Percy's "Metallurgy," he will find on page 778 that this is described as "the ancient method, which is still extensively practiced on the Continent, especially in Syria;" and further down on the same page that "if steel be regarded simply as iron carburised in degrees intermediate between malleable and cast iron, then it is obvious that the latter, during its conversion into the former in the processes of fining and puddling, must pass through the state of steel. On page 805 of the same work he will find further confirmation of his theory in the words, "it is obvious that steel must be produced by melting malleable and cast iron together in suitable proportions."

I might multiply quotations from this and every other work I have seen in which the chemistry of iron and steel is treated, and show by each of them that the thousand-and-one of unfortunate inventors who have struggled in vain to make steel directly from English pig-iron, have been encouraged in their delusion by the teachings of high chemical authorities.

"If steel be regarded simply as iron carburised in degrees intermediate between malleable and cast iron," these inventors are perfectly justified in seeking some substance which at the melting heat of cast iron shall give off a definite quantity of oxygen; and they have logical grounds for believing that by bringing such a substance in contact with the molten cast iron, and properly regulating its quantity, they may burn out just that surplus carbon which makes all the stated difference between cast iron and steel. As a multitude of compounds when thus heated do give off oxygen, a vast field of effort is open, and accordingly every available peroxide and decomposable oxygen salt has been administered by strange devices to the melted iron, the same obvious substances used over and over again, and the same failures continually repeated by expectant inventors, ignorant of what each other have done or are doing. Gas and vapors have been blown over the surface and under the surface, and through from bottom to top of melted cast iron, and all (including Mr. Bessemer) have failed to produce merchantable steel from ordinary English cast iron, without first making it into malleable or wrought iron.

The reason of this is, that the removal of the surplus carbon is only a small portion of the work which has to be done in order to convert cast-iron into steel of any commercial value. Several other substances have to be removed also; *and no process has yet been discovered by which these impurities can be removed without at the same time removing the carbon in corresponding degree.* I put this in italics because I am convinced by experience of its great practical importance; because I do not find it clearly and distinctly enunciated in any general or special treatise; and further, because I have seen so plainly that the want of clearly understanding it is the rock upon which so many unfortunate inventors have split.

These inventors have not been informed with anything like the necessary degree of distinctness, that the Styrians and others who have made, or are making, steel directly from cast-iron, have started with a very different material to that which bears the same name of cast-iron in England; the difference being sufficiently great to alter totally the conditions of the problem. The cast-iron of the Styrian steel-makers is a nearly pure carburised iron; *our* cast-iron is a carburised, silicised, phosphorised, and sulphurised iron; *their* problem in steel-making is, merely the partial decarburisation of their cast-iron; *ours* is the total destilisation, the total dephosphorisation, and the total desulphurisation in addition to this. Now, the partial removal of carbon from iron is one of the very easiest problems in practical metallurgy, while the complete removal of silicon, phosphorus, and sulphur, is among the most difficult.

To illustrate the grossness of the fallacy which represents the difference between cast-iron and steel as merely, or "essentially," due to carbon, I may state that on looking down a tabular statement of the analysis I have recently made of thirty brands of ordinary English pig-iron (excluding hæmatite pig), I find that seven of them contain less than 2 per cent. of carbon, or an average of 1.67 per cent. Now this is below the percentage of carbon which exists in some of the finest and most expensive samples of cast-steel. Therefore, to convert these particular brands of cast-iron into the finest steel, the carbon must neither be increased nor diminished, and if, as Dr. Percy says, the difference between steel, wrought-iron, and cast-iron, "*essentially* depend upon differences in the proportion of carbon," all these brands of pig-iron should be described as steel rather than cast-iron.

Nevertheless they are utterly worthless for any of the purposes for which steel is used, and the common result of the costly experiments of the inventors who endeavor to make steel directly from English pig-iron, is to produce a material very much like them. They usually succeed perfectly in their effort partially to decarburise the pig-iron. They take out, say one half of the carbon, and with it a considerable portion of the silicon, and *some* of the phosphorus, sulphur and manganese; but to make a *perfect* steel they must take out *all* of these latter, and leave nothing but pure iron and carbon. Absolute perfection is not, of course, practically attainable in steel-making, but it is approximated in exactly the same degree as the purification of the iron from everything excepting the carbon is effecting.

The most notable modern attempt to produce steel directly by the simple decarburisation of English cast-iron was that of Mr. Bessemer. His first idea was to blow air through melted cast-iron, and thereby to oxidise the carbon, and then, when a sufficient degree of decarburisation was effected, to stop the blowing. He supposed that when by this means the proportion of carbon was reduced to about one and a half per cent. the result would be useful steel. He failed entirely in this. He never succeded in producing merchantable steel from ordinary English cast-iron by this method.

The Bessemer process, as at present conducted, consists in first oxidising simultaneously all or nearly all the carbon and silicon, and then adding to the decarburised iron a new dose of carbon, by means of a known quantity of spiegeleisen of known composition; thus reverting to the old Sheffield principle of first bringing the cast-iron to the state of wrought or decarburised iron, and then adding carbon to convert it into steel.

It is commonly represented that the failure of the early attempts at direct steel-making by the Bessemer process arose simply from the difficulty of determining the right moment at which to stop the blow, and thereby to regulate the proportion of carbon; and that the whole advantage of the spiegeleisen is the means it affords of doing this. Dr. Percy says:—"In attempting to produce steel by the methods specified by Bessemer, it has hitherto been found very difficult, if not impracticable, *at least in this country*, to ascertain with certainty when decarburisation has proceeded to the right extent, and when therefore the blast should be stopped. Accordingly the plan now adopted is to decarburise perfectly, or nearly so, and then add a given proportion of carbon in the state in which it exists in molten spiegeleisen, the precise composition of which should of course be known."* Neither in Dr. Percy's nor any other account of the Bessemer process do I find that the necessity of complete decarburisation as a means of completely separating the silicon is fairly appreciated.

If merchantable steel could be made from English pig-iron by simply stopping the blow before complete decarburisation, Mr. Bessemer would surely have produced some good steel in the course of hislong and costly efforts which preceded the idea of introducing the spiegeleisen, for it must be remembered that the quantity of carbon required in steel extends over a very wide range—that steel may contain from 0.40 to 2.00 per cent. of carbon, and that steel with every degree of carburisation within this wide range is in demand in the market at good prices, provided it be free from phosphorus, silicon, &c. Nothing is practically easier than to stop the blow at such a moment as shall insure the degree of carburisation somewhere between this wide range; and there can be no doubt that, in his early experiments, Mr. Bessemer, like other inventors of direct processes, made an abundance of iron that was duly carburised within the above-stated limits, although he failed to produce useful steel.

Dr. Percy's qualification, "at least in this country," is rather curious. He has probably learned that steel has been directly made in Sweden (though he does not mention it in his work) by the Bessemer process, and he seems to attribute this to the superior ability of the Swedish operators, enabling them "to ascertain with certainty when decarburisation has proceeded to the right extent." I differ entirely from Dr. Percy in this conclusion, being convinced that Mr. George Brown, the manager of the Bessemer Department at the Atlas Works, Sheffield, who was the first to work the Bessemer process with commercial success, is better able (on account of his much greater experience and thorough knowledge of the work) than any of the Swedish manufacturers, to determine when any required degree of decarburisation has been attained. It is not the superior skill of the Swedish operators that has enabled them to make steel directly by the Bessemer process; but the fact that they, like the Styrian workers, used very superior charcoal-iron to start with; and that the blowing out of all the carbon was not absolutely necessary for the sufficient purification of this quality of iron. —*Nature, Aug.* 18.

* "Metallurgy," "Iron and Steel," p. 814. The italics are my own.

—Mr. Miller, the General Superintendent of the Chester & Chicago Branch Junction Railroad Company, advertises for proposals for building twenty-three miles of the road, from Chester to Sparta. Plans and specifications of the work may be seen at the office of the Chief Engineer, Mr. Joel R. Woodruff, at St. Louis.

RAILROAD GAZETTE

PUBLISHED EVERY SATURDAY.

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Editorial Announcements.

Correspondence.—We cordially invite the co-operation of the Railroad Public in affording us the material for a thorough and worthy Railroad paper. Railroad news, annual reports, notices of appointments, resignations, etc., and information concerning improvements will be gratefully received. We make it our business to inform the public concerning the progress of new lines, and are always glad to receive news of them.

Articles.—We desire articles relating to railroads, and, if acceptable, will pay liberally for them. Articles concerning railroad management, engineering, rolling stock and machinery, by men practically acquainted with these subjects, are especially desired.

Inventions.—Those who wish to make their inventions known to railroad men can have them fully described in the RAILROAD GAZETTE, *if not previously published,* FREE OF CHARGE. *They are invited to send us drawings or models and specifications. When engravings are necessary the inventor is expected to furnish his own engravings or to pay for them.*

☞ *Our Prospectus and Business Notices will be found on the last page.*

MR. M. N. FORNEY, whom many of our readers will remember as a mechanical engineer of ability and reputation, formerly connected with the Illinois Central locomotive works and other manufacturing establishments, has been engaged as associate editor of the RAILROAD GAZETTE. Mr. Forney will have especial charge of matters relating to engineering and mechanics. In the course of the year he will visit railroad shops and manufactories in many different parts of the country, to confer with engineers and mechanics, observe new structures, machines and processes, and procure information which will be valuable to railroad men. We especially commend him to those whom he may visit.

Mr. Forney's office is at Room 7, No. 72 Broadway, New York.

THE MASTER MECHANICS' CONVENTION.

If transportation is ever to become a science it must grow as all sciences do, from facts or "phenomena" which manifest themselves to careful observers. We say *careful* observers, because, in studying any science, one of the greatest obstacles in the way of coming to sound conclusions is the difficulty of getting accurate data to reason from. A perfectly impartial and accurate observer of facts, exactly as they occur, is one of the rarest persons in the world. It requires what is a very unusual combination of traits and faculties—perfect truthfulness, self-posession, promptness, accuracy and impartiality. Prejudices and previous conceptions must be laid aside and not allowed to warp the perceptions, and every faculty must be alert or wide-awake to see all that is to be seen. The great difficulty is that most persons observe and collect data more with a view of confirming their previous opinions than with the intention of changing them if not sustained by their observations, very much as some people read the Scriptures: *i. e.*, not so much to learn the truth, as to find proof for their own doctrines.

We make these observations in order to direct the attention of the members of the convention to the importance of great care in the collection of data and statistics and the results of experiments. A record of a fact which is not accurate is worse than no record, and if the reports of the committees should be unreliable or carelessly compiled, their value would be destroyed. False reasoning is not nearly so mischievous as false facts (if such an expression is allowable); because most of us can detect an error in the reasoning, but it is impossible for us to tell whether a record of facts is true or not. We trust, therefore, that the members of the committees will exercise much discrimination in the collection of data, and sift the wheat from the chaff very carefully before they present their reports to the convention or to the public.

It needs only a glance at the list of subjects on which reports are to be read, and which we suppose will be fully discussed in the convention, to see that the information which can thus be collected must be very valuable, not only to the members of the convention, but to the railroad companies which they represent. Even if no other result were accomplished than to state definitely the questions and problems which press most for solution, much good will be accomplished. When a man is sick the first steps towards being cured is to learn what ails him; and this, by the way, is often the most difficult and perplexing step of all. So of railroads which are "indisposed" to pay dividends: a distinct statement or diagnosis of the disease which eats up the vitals of their treasury is the first and usually the most important step in the direction of remedying the evil. Take the first subject for discussion in the convention: "Can the dead weight in rolling stock be materially reduced? An ordinary freight engine, with tender containing fuel and water, weighs from 50 to 55 tons, while the weight available for traction * is about 20 tons. In cars the proportion of dead weight to load carried, either freight or passenger, is very great."

Now here is a distinct statement of an evil which has of late been talked about a great deal in a vague sort of way, but is not usually put in quite so concise a form; and like most evils, when they are fully realized, it is found to be greater than an easy and careless tolerance supposed it was. That an ordinary freight engine with tender, which weighs from 50 to 55 tons, has only 20 tons, or two fifths, available for adhesion, is a "subject" which we think it will be profitable for the whole convention to look full in the face.

In this connection it would be extremely opportune if some information were contributed showing the cost per ton per mile of carrying dead weight. It is a problem not so easy or simple as it at first appears, and involves some very complicated conditions and calculations.

On the second subject,—"Is it advisable to establish uniform sizes for locomotive tires, in order that manufacturers and dealers may keep a stock on hand and be enabled to fill orders promptly, thereby doing away with the necessity of railway companies keeping a large supply on hand as is now done?"—we think the committee might make a monosyllabic report and say yes, without much further reflection. The sizes to be adopted for tires it is perhaps more difficult to determine. This could be decided best if each Master Mechanic would contribute a list of the sizes and the number of tires of each size in use on his road, and then have the whole put into a tabular form.

The third subject is, "What is the most approved form for locomotive furnaces to insure combustion and develope the value of the fuel used? be it either wood, anthracite or bituminous coal, utilizing the greatest amount of fuel and most effectually consuming all gases, and whether increasing the area of the combustion chamber in fire box at expense of length of flues is not desirable."

This will probably call out the warmest discussion of all and is perhaps the most important subject in the list. Inasmuch as the whole question of the economy of of fuel is involved, and also the collateral one of cleanliness and freedom from cinders, the report will be looked for with much interest.

Fourth. "What shall be the length and width of openings—outside and inside lap, lead and travel—of slide valves to insure greatest economy and efficiency for any given diameter of cylinder?"

On this there are almost as many opinions as there are master mechanics, and there does not seem to be much prospect that any definite or conclusive answer can be given to the queries.

Fifth. What is the best material for flues and the best manner of setting the same for both wood and coal burning locomotives.

Sixth. "What lateral play should be allowed upon the rail for driving and truck wheels of locomotives, insuring the greatest degree of safety without increasing friction."

Experience is the only safe guide in answering these questions. Doubtless the members will have much information to contribute.

Seventh. "What is deemed the proper standard for square and hexagon nuts, and what would be considered the proper standard of thread for given size of bolts?"

Some standard size of nuts and threads is doubtless very important to all railroads, but the difficulty is in establishing one which all will agree to. Several different authorities have established "standards" in this country, and it is very desirable that some one of them should become *universal*. If a new one is adopted, it will only increase the present confusion, so that obviously the best plan will be to endorse some system now in use.

Eighth. "Is there any advantage in changing our mode of applying brakes? Say to apply the retarding force to the rail instead of the wheel."

The committee will be safe in answering *no* to this conundrum.

Ninth. "What would be the best system of uniform reports of operating expenses of the motive power department of the railways of America?"

This subject can only be handled properly by a long report, and if the committee do not give us some information and new ideas about it, we will conclude they have not done their duty. The accounts of one road, as they are now kept, are usually to a considerable extent incomprehensible to the employers of another road. One practice—such as allowing mileage for freight engines for switching—will prevail on some roads, while the reverse will be the custom on others; so that an accurate comparison of the performance of engines on one line with those of another is almost impossible.

Tenth. "What form of engine is best adapted, in point of efficiency, durability and economy for hauling freight trains?"

The consideration of this subject at the present time will involve a discussion of the merits of the Fairlie and some other forms of locomotives which have been brought forward within the last few years. The views and expressions of master mechanics in reference to these machines will go far toward either their introduction or abandonment.

We venture to suggest one topic for consideration in this connection, *i. e*, to what extent is a *variable* weight on the driving wheels objectionable. The weight of the fuel and water of course varies, and if carried by the driving wheels must increase or diminish their adhesion.

We print in another column an extract from the report by Benjamin H. Latrobe, C. E., made to the North Missouri Railroad in 1866, in which he takes strong ground in favor of six and eight-wheel connected engines for slow freight. His reasoning is at least worthy of consideration in this connection.

One word more of criticism, and that not because we are inclined to under value the proceedings of the convention, but because we want its records to be as useful as possible: Would it not be better to give more figures and statistics, and less account of the festivities, etc. of the convention? Give more of the figures from which the committee draw their conclusions, and any fallacious reasoning, if there be any, can then be detected. After-dinner speeches which are inspired by conviviality, are usually not very well worth recording, although pleasant to listen to. The annual report of the Master Mechanics Convention purports to be, and should be, a scientific document and should be characterized by all the dignity of science, some of which is certainly lost when we read towards the end that "the bill of fare was excellent, typographically, and not wanting in other respects," and the "the banquet was enlivened by music by the band, operatic selections, etc."

The convention has grave duties before it, and if he who makes two blades of grass grow where one grew before is to that extent a benefactor to mankind, certainly they who make one pound of coal do the work of two are not useless. If the master mechanics by meeting in convention and exchanging their knowledge and experience can lessen the cost of transportation, reduce the danger and risks to travel, or make it less fatiguing, more pleasant, or quicker, they will benefit not only those who immediately make the profit and advantage, but will be adding a positive quantity to the wave of advancing civilization and happiness.

*The word *traction* is obviously used inaccurately in this connection and may lead to some confusion. Webster's definition of "traction" is, "the act of drawing or state of being drawn; as the traction of a muscle." The traction of a locomotive is the power which the pistons exert to draw a load, and is dependent upon their area and stroke, the pressure of the steam in the cylinders, and the diameter of the driving-wheels, and is independent of the weight. Evidently what is meant by the word "traction" is *adhesion*.

THE NEW CLASSIFICATION OF FREIGHTS proposed by the committee of the General Freight Agents Association appointed for that purpose, has been approved, we learn, by all who have reported their opinions.

THE CHICAGO & NORTHWESTERN REPORT.

We give herewith some comparisons which are not made in the report itself. It gives the total decrease of earnings for the year as $1,252,213, or a little more than ten per cent. The earnings of each division are given separately, but no comparison is made by divisions. By examining former reports we find that the earnings of the last year though so much less than those of the previous year, were not a hundred thousand dollars less than the earnings of the year 1867–68, ($79,418.25, exactly), and more than two millions greater than those of the previous years, when, however, the mileage was not so great by 115 miles. The operating expenses and taxes for the last year, however, did not shrink with the earnings, but were greater than ever before, and $88,797.26 greater than in 1868–69, when the earnings were greatest. This is less than one per cent., but even this is felt when the earnings fall off ten per cent. On examination we find that in this year of light business (comparatively) the expenses for repairs have been heavier than the previous year by nearly $175,000, and this increase is shown in car and locomotive repairs as well as in track and road bed, which would lead one to suspect that in that very prosperous year some repairs may have been put off to a more convenient season. Aside from repairs, few items of expenses show any noticeable increase. There is some addition to the expenses for foreign agents and advertising easily explained by the increase of competition. Nearly $18,000 more was spent for agents and clerks at stations, $9,000 more for rents, $4,000 more for injuries to persons, $20,000 more for insurance, $20,000 more for clearing snow and ice, and $55,000 more for "miscellaneous expenses."

On the other hand there is a decrease of $114,000—more than ten per cent.—in the single item of locomotive fuel, $14,000 in engineemen, firemen and wipers, and smaller sums in most of the other items. Evidently the increase in expenses—and perhaps we may say the cause why expenses were not reduced with the earnings—is due to the large amount of repairs; and we imagine that the line was in better repair at the end than at the beginning of the last fiscal year. The percentage of expenses to earnings was 56.58 in 1868-69 and 63.93 in 1869-70.

Comparing the earnings of the different divisions with those of the previous year, we find that there was a decrease of nearly $300,000, or nine per cent., on the Wisconsin Division; a decrease of about $384,000, or 8⅓ per cent., on the Galena Division; a decrease of $860,000, or *more than twenty per cent.*, on the Iowa Division; a decrease of $10,000, or 4½ per cent., on the Madison Division; an *increase* of $189,000, or *thirty-seven per cent.*, on the Peninsula Division; and a decrease of nearly $32,000, not quite three per cent., on the Milwaukee Division. Thus the chief decrease is shown to be on the Iowa Division of 354 miles. We have not far to look for the cause of this. Doubtless it was chiefly due to the total cessation of the business of transporting materials for the construction of the Union Pacific, a business which added hundreds of thousands of dollars to the earnings of this division in 1868–69. The sources of earnings on this division are not given in the report for 1868–69, but we suppose that, with the exception of this transportation of materials for construction, the actual business of the line was nearly or quite as heavy last year, though it is quite probable that the receipts, and especially the net earnings, were considerably less. It is true that there are now two other lines competing for a business of which the Northwestern had the monopoly, but since the completion of the Union Pacific that business has so increased that each line may easily have as much business as the one had before. But with competition has come a decrease in rates and an increase in expenses, which on this line amounted last year to the very painful proportion of 74.19 per cent. of the gross receipts. But the Wisconsin and Madison divisions appear almost as badly, with 72.74 and 72.37 respectively as the percentages of their operating expenses. On the other hand the Galena, Peninsula and the Milwaukee divisions make excellent showings of 53.36, 57.34, and 52.47 per cent., respectively, which are sufficient to show that when the lines have a fair opportunity they will make excellent returns, and that the reputation of the managers for ability is well deserved.

Below we give a comparative statement of the percentages of expenses to earnings on the different divisions for the three years last reported:

	1867–8.	1868–9.	1869–70.
Wisconsin Division	63.67	59.67	72.74
Galena "	57.82	56.90	53.36
Iowa "	69.12	62.43	74.19
Madison "	67.62	61.73	72.37
Peninsula "	62.65	59.50	57.34
Milwaukee "	51.62	49.77	52.47
Entire line	62.42	56.84	63.93

There are many reasons for believing that the current year will make a much better showing. The crops almost everywhere on the company's lines are unusually heavy. The extension of the Minnesota road owned by the company must bring to its lines east of the Mississippi a considerable increase of business. The rapid growth of the population and wealth in Iowa and of the area of cultivated soil, is sure to give this line a great addition to its traffic immediately and make it eventually one of the best of the company's lines. And with increased business we shall not be surprised to see decreased expenditures. Certainly the strictest economy is now enforced, and the company's work has never been done so cheaply before, since the war.

Looking further ahead, beyond the current year, the prospects are even more favorable. A year from this time the company will have nearly completed an independent connection to St. Paul, shorter than any now existing and nearly an air-line. It will have nearly closed the connection with its own very valuable line in Minnesota and with the whole system of railroads in that State. It is more than probable that additional connections will have been added in Iowa, and perhaps in Illinois, to those in Wisconsin and Minnesota, and the company's system will be complete and independent.

Principles of Tractive Power in Locomotives.

BY P. BARNES, JR.

The power of any locomotive is limited by the *friction* or resistance to slipping or sliding between the tread of the driving wheel and the rail. The word "adhesion" is sometimes used in this connection, but it can be applied with correctness only to a resistance like that which is offered to the shearing of a body, as a bar of iron, in which the particles of the metal are forced to move or slide upon themselves while the shearing is taking place. Hence the ability of an engine to move a load will depend upon *the weight resting upon its driving wheels and the condition of the surface of the rail*, because the most careful special experiments and extended observation in practice show that in common with metals so nearly similar in character as rails and tires, whether of iron or steel, the friction is almost exactly proportional to the perpendicular pressure between the surfaces, or, in the case of the locomotive, to the pressure upon the rail. It is by this friction that the wheel is prevented from revolving freely when pressure is brought upon the piston, and this friction is always greatest, and the engine can draw the heaviest loads, when the rail is either perfectly dry or perfectly wet, so that the surface of the tire may come into close contact with the surface of the rail without the intervention of any slippery film of moisture.

The general law, deduced from the most exact experiments, is that the force required to move one body when sliding upon another corresponds very nearly to the perpendicular pressure between them multiplied by the *coefficient of friction*. This coefficient is simply the relation or proportion which the pressure required to move a body upon any surface bears to the weight of the body itself, and for general purposes may be stated to be from 1-20 to 1-10 between metals when properly oiled. If the surfaces are not properly smoothed, or if the pressure between them is so great as to produce grinding or abrasion, then this law will not hold good, but the coefficient will increase rapidly to a point determined by the special condition of the case. It is also evident that this coefficient or proportion will diminish when the surface sustaining the weight of the rail, in the case of the locomotive, becomes more slippery than usual, as when snow or ice accumulate on the track, or sometimes during a slight rain, and hence, as is well known, the tractive force of any engine may be very greatly reduced at such a time.

Since then the power of a locomotive depends so entirely, other things being equal, upon the weight carried upon its driving wheels, it might seem necessary merely to increase the total weight of the engine by loading it with pig iron in order to increase its tractive powers; but further consideration will show that this is not true. To illustrate the actual state of the case, suppose a locomotive to be firmly attached to a solid rock which cannot be moved. If steam be then admitted to the cylinders, a pressure will be brought upon the driving wheels tending to make them revolve, and, in this supposed case, they can only slip upon the rail. This slipping will always take place when the pressure upon the piston due to the steam within the cylinder is greater than the product of the weight of the engine multiplied by the coefficient of friction, since, as has already been shown, there is no other means than this of holding the wheels to the rail. Slipping will not occur in this case if the pressure upon the piston is less than the product of these two factors. If the weight of the engine be not great enough to prevent slipping for any given size of cylinder or pressure of steam, then an increase of weight may usefully be made so that this product may be increased by which, as has been shown, the tractive power of the engine is measured or limited.

It will be seen, then, that with any given size of cylinder and standard pressure of steam a certain weight must be given to the locomotive, so that, under ordinary circumstances of weather, etc., no slipping of the wheels may occur, and also that no useful result can be obtained by increasing this weight beyond this certain amount; for the pressure upon the pistons cannot be increased beyond this assumed limit, and hence no additional load can be drawn, even though no slipping should take place.

The objection urged against the use of six-coupled engines, that they have a long rigid wheel base, is an important one, and it is receiving serious attention in England, where these engines are vastly more common than in this country. Few builders, however, would put three pairs of driving wheels under any engine without making the boiler and other parts longer or heavier, so as to furnish a weight to be borne upon each pair of wheels equal, or nearly so, to that borne by each pair of wheels of an ordinary four-coupled engine, so that the larger engine may be efficient just in proportion to its size.

The grand objection to any increase of the weight of our engines, as now constructed, is that it is too destructive to the track to load each pair of wheels even as heavily as is ordinary now. The blows dealt by passing wheels upon the rail joints, and the bending or breaking strain brought at any instant upon the joint in the rail where a wheel presses, depend upon the weight which the wheel carries as well as the speed at which it moves, and hence to diminish our track repairs, that which is nearly or quite the most greedy of all maintenance accounts, the load borne per wheel in our locomotives must be lessened at least one half, so that it may more nearly agree with the load borne per wheel in the cars. How this can be done without increasing the rigid wheel base, while the present boiler and cylinder capacity are retained, is one of the most trying problems of the present day among locomotive builders, and certainly the most promising commencement of its solution is the introduction of the Fairlie engine, notwithstanding the numerous complications with which it is still beset.

REGISTER OF EARNINGS.

FOR THE MONTH OF AUGUST.

Pacific of Missouri (355 miles), 1870		$343,194 00
" " (355 miles), 1869		262,515 00
Increase (30¾ per cent.)		$80,679 00
North Missouri (404 miles), 1870		$329,099 99
" " (404 miles), 1869		155,586 00
Increase (47⅛ per cent.)		$73,513 99
Milwaukee & St. Paul (936 miles), 1870		$660,969 00
" " (825 miles), 1869		525,363 00
Increase (25¾ per cent)		$135,606 00
St. Louis & Iron Mountain ($10 miles), 1870		$122,000 00
" " " ($10 miles), 1869		69,967 75
Increase (74½ per cent.)		$52,032 25
Chicago & Northwestern (1,157 miles), 1870		$1,246,213 00
" " (1,157 miles), 1869		1,037,973 00
Increase (20 per cent.)		$208,340 00
Chicago & Alton (465 miles), 1870		$501,049 86
" " (431 miles), 1869		493,231 51
Increase (1½ per cent.)		$7,818 35
Illinois Central (974 miles), 1870		$861,357 88
" (862 miles), 1869		841,363 33
Increase (2⅓ per cent,)		$19,994 55

LOCOMOTIVE STATISTICS.

Burlington & Missouri River.

Mr. George Chalender, Master Mechanic of the company, makes the following report for the month of July, 1870:

Miles run by passenger trains	37,044
" " freight trains	57,767
" " miscellaneous trains	37,990
Total number of miles run	132,801

The average cost per mile run was:

For repairs	4.66 cts.
" oil, waste and tallow	0.87 "
" fuel	6.97 "
" engineers, firemen and wipers	7.71 "
Total cost per mile run	19.61 cts.

The average number of miles run was:

To one ton of coal	48.91
" " pint of oil	14.57

Coal is charged at $3.50 per ton, and wood at $3.40 per cord. Forty-four locomotives made mileage during the month, one is in shop, and two were in shop part of the month. All of the locomotives, except two, are coal burners.

—The American Bridge Company, of Chicago, have been awarded the contract for building the Court Avenue roadway bridge across the Des Moines River at Des Moines. It is to be a double track bridge, all iron (Post patent), 600 feet long with four spans, with sidewalks outside of each truss, with iron hand railings.

Chicago Railroad News.

"Special Notice."

A placard with the above heading posted in various conspicuous positions in the Central Depot in this city reads as follows:

"No charge will be made by depot men for transporting or roping baggage. Depot men will be held personally responsible for the careful handling of baggage! The interests of the companies and those of the passengers in this matter must be respected."

The Ticket and Freight Agents' Excursion.

The passenger, freight and ticket agents who have accepted the invitation to make an excursion over the Pacific railroads will leave Chicago for Omaha next Monday. The three lines from Chicago have issued special invitations to the agents and their ladies for the journey between Chicago and Omaha. A large number will go from this city, and we learn that a very general attendance is probable.

Freight Business.

Last Thursday rates from New York to Chicago were advanced about twenty-five per cent., and now are $1.25 for first class, $1.10 for second class, 85 cents for third, 65 for fourth, and 50 for special. Rates from Chicago eastward remain firm at the rates adopted two weeks ago. Apparently business has not suffered because of the advance, for the lines have a heavy traffic both ways, and especially eastward.

Business on all the lines which bring produce to Chicago is heavy, though not so heavy on some as it was a week ago. There is an immense crop to carry, and our roads expect to find use for all their rolling stock until it is forwarded. The increase in the number and business' of the lines which cross this State south of Chicago, has a tendency to take business from the lines which extend southward and southwestward from this city; but the increased business of the country will more than counterbalance this, and these roads, in all probability, will find the next twelve months the most profitable in their history.

Chicago & Alton.

The business for the last half of August did not compare so well with that of the last year as did the first half; but though the earnings were less this year, they were still large, last year's earnings being extraordinarily large. The last week, for instance, shows a falling of $8,044.15, yet the earnings for that week were $132,508.77, while the average for the year has been but about $86,400. The earnings for the first eight months of the year were:

1870	$3,025 185 55
1869	2,968,361 04
Increase	$56,824 51

Illinois Central.

The traffic on this line is now working the rolling stock pretty nearly up to its utmost capacity. Grain is coming in great quantities, and there are large shipments of lumber from this city over the line. Everywhere on the company's lines, from Cairo to Chicago and from Centralia to Sioux City, the crops are enormous, probably the heaviest that were ever known; not that the average per acre is larger than in the extraordinarily productive season of 1860, but that there is two or three, or more, times as much land under cultivation on the company's lines.

On the other hand, the heavy grain crops in the South, especially in Kentucky and Tennessee, are likely to limit somewhat the demand in the South for corn from Illinois, and have an unfavorable effect on shipments of that grain in that direction over this road. But this decrease in the demand for corn is likely to be made up by the heavy demand for flour, provisions, and other products, which may reasonably be expected now that the South is prosperous.

The company's receipts from traffic and land sales during the month of August are given below:

LAND DEPARTMENT.

Acres construction lands sold	5,597.80	for	$56,535 79
Acres interest lands sold		for	
Acres free lands sold	280	for	5,739 60
Total sales during month of August, 1870	5,877.80	for	$62,275 39
To which add town lot sales			1,180 00
Total of all	5,877.80	for	$63,455 39
Cash collected in August, 1870			$176,857 75

ESTIMATED EARNINGS—TRAFFIC DEPARTMENT.

	In Illinois 707 miles.	In Iowa 267 miles.	Total. 974 miles.
Freight	$518,735 05	$92,432 08	$611,167 00
Passenger	136, 78 13	40,037 75	176,815 88
Mails	6,375 00	1,029 8	7,404 8
Other Sources	64,000 00	1,97[illegible] 92	65,97 92
Total, Aug., 1870	$725,288 13	$136,069 75	$861,357 88
Total actual earnings, Aug., 1869	$720,330 61	$120,[illegible]82 72	$841,363 33
Increase	$4,957 52	$15,[illegible]87 03	$19,994 55

This shows an increase on all divisions, though but about ⅝ of one per cent. on the Illinois lines. On the Iowa lines the increase is 12½ per cent., and on all the lines about 2 2-5 per cent. There was a decrease in July.

Chicago & Northwestern.

Business is not quite so heavy as in the latter part of August, but there is nevertheless a considerable increase over last year, amounting to something like $3,000 per day.

The contract for constructing the first twenty miles of the Madison and Winona extension, from Madison to Lodi, was let last Wednesday to Fox & Howard of this city, to be completed ready for the iron by the 1st of April next. The company will put down the iron as fast as the road bed is ready.

Chicago, Rock Island & Pacific.

Mr. E. H. Johnson, Chief Engineer of the company, has been in Rock Island the past week arranging for the commencement of work on the Slough Bridge which is to connect the railroad with the new government bridge over the Mississippi. Work on the coffer dams for the abutments was begun this week.

Mr. E. St. John, the General Ticket Agent, has issued the following circular to the general ticket agents of other roads:

"The Chicago & Southwestern Division of this road now being completed from Washington, Iowa, to Leavenworth, Kansas, will be opened for business to Fairfield, Iowa, October 1st, 1870.

"We desire that you issue, as soon as practicable, First and Second Class Coupon Tickets to this point, to be placed on sale at your Coupon Offices on the above mentioned date.

"But one Coupon from Chicago will be necessary, reading Chicago, Rock Island & Pacific Railroad, Chicago to Fairfield.

"Through baggage checks to principal points, have been ordered for this station, by this line."

The line here referred to extends from Washington, the southwest terminus of a branch of the Iowa Division of the Rock Island road, southwest 25 miles to Fairfield, the county seat of Jefferson county, and a station on the Burlington & Missouri River Railroad 50 miles west of Burlington. By the new line it is about 100 miles from Davenport and 283 miles from Chicago.

A strong effort is made by the people between Washington and Oskaloosa, Iowa, to induce the company to extend its Washington Branch from Washington westward. The company asks of Sigourney, 25 miles west of Washington, $50,000, the right of way and depot as the condition of making the extension to that place by December, 1871.

Pittsburgh, Fort Wayne & Chicago.

A notice in the GAZETTE last week of the remarkable success of the fast train on this line was, by some unaccountable and almost inexcusable blunder, put under the head of "Pittsburgh, Cincinnati & St. Louis," which, as everybody is aware, has not been running trains to New York in twenty-seven hours "to any great extent."

Rails and Locomotives.

The following is a portion of a report made in April, 1866, by Benjamin H. Latrobe, C. E., at the time Consulting Engineer of the North Missouri Railroad, on rails and engines. It was addressed to Isaac H. Sturgeon, Esq., then President North Missouri Railroad Company:

You have asked my opinion, as your consulting engineer, as to the rails, engines and cars which it would be best to use upon the proposed nothern and western extension of your road, and I submit the following replies:

1st. *The Rail.*—At the present high price of iron, the weight of rail you may find it expedient to employ must depend upon the amount of capital you may be able to command for the construction of your road. If that will allow the use of a rail of sixty pounds to the yard, I would recommend it to be that weight; but you may reduce the weight to even as low as fifty pounds without risking the failure of your work as a first class line of travel and trade. I would say, then, let your rail not be below fifty, and as near sixty pounds as your construction fund will permit. I would add that I would prefer a lighter rail, within those limits, with a good fished splice, to a heavier one with an ordinary cast or wrought iron chair; and, further, that the base and height of rail being fixed at say 3½ inches for each, I would not make them different from those dimensions for any weight between fifty and sixty pounds, but would put the increase of weight chiefly into the top part of the section, which is subjected to the crushing and wearing action of the wheels. The lighter your rail, the nearer to each other your cross-ties should of course be placed, and the deficiency in the weight of rail should be provided for in this way, that an equal strength and stiffness in the whole structure may, as near as possible, be secured, notwithstanding that deficiency. The cross-ties should be seven inches thick, with at least the same bearing surface, top and bottom, and eight feet long. Upon all soils retentive of moisture ballast of broken stone or gravel should be used of a thicknesss of at least a foot, and even upon porous soils it should ultimately be employed when transportation is provided by the completed track.

2d. *Engines.*—These should be of two distinct classes—one for *freight*, and the other for *passenger* trains—the former designed for heavy draft at low speed; the latter for lighter loads at much higher velocities. Upon the observance of this principle the *economy* of transportation chiefly depends. The *freight* locomotive of the railway is the wagon horse of the turnpike, slow paced, weighty, and powerful; the *passenger* locomotive is the fast, light and active animal of the mail coach. The analogy is obvious, but it is not acted upon as universally as it should be, and hence we see *moderately* long trains, loaded with heavy tonnage, flying along our railways at twenty miles or more per hour, and drawn by engines constructed more for speed than power, when we should see much longer trains, moved at ten miles per hour, by locomotives built for this more effective, although less showy service. A powerful engine, designed for slow motion, should have large cylinders and small wheels, and all of these last connected, so as to make the power exerted through its cylinder fully effective. To uncouple one or two pairs of wheels from the rest in which the power acts, is to *throw away* just as much power as the weight which they bear will afford through their adhesion to the rails. The locomotive engines of America, (and we use no others now,) are built with four, six, eight and ten wheels, and some even with twelve wheels. The four and six wheel engines are now used almost wholly as switching engines at stations and have all their wheels connected. The eight wheel is the most numerous class, with two pair connected with the power as drivers for passenger and freight purposes, or with the whole four pair as drivers for freight altogether. The ten-wheel have three pair of drivers and two pair of wheels in a front truck, and the few with twelve wheels are similarly arranged, with a four wheel truck in front and eight drivers behind. All these different classes have their appropriate duties. The four and six-wheel machines are the best for yard sevice, being compact and powerful, and turning short curves well. The eight-wheel are for the general passenger and freight business of the road. For the former (passenger) they should have the two hind pair as drivers, and the two front pair as guides in their track frame—not being required to draw loads which would bring the adhesion due to their whole weight into play, but only such loads as can be started with the adhesion of about two-thirds of their weight, which is the usual proportion resting on their drivers. For the latter, (freight,) however, they should have the adhesion of their whole weight, as they are required to exert their fullest power in starting their long heavy trains, and in ascending the steepest grade they meet upon their trip. The ten and twelve-wheel engines are intended to combine power and speed for such trains as demand this combination, such as live-stock and fast freight trains carrying goods of a lighter or of a perishable description. Hence, while they have from three-fourths to four-fifths of their weight upon their drivers, they are furnished with a truck in front to guide them at high speeds around the curves and relieve them of overhanging weight before and behind, and thus produce more steadiness of motion at such speeds.

Upon such a line as the North Missouri, with its extensions northward and westward, I would, however, recommend (besides the yard engines) only two classes of locomotives for the present at least. These would both be eight-wheeled; one class the usual four-driver passenger engine, to be used also for fast freight and stock trains; the other class a freight engine, with all its eight wheels drivers—not exceeding four feet in diameter (forty three or forty four inches would be best) and with cylinders of such size as not to require steam of more than one hundred pounds to the square inch effective pressure to slip the wheels upon a clear rail, with a boiler of such proportions as would supply steam of that pressure for a speed not exceeding twelve miles per hour, with ordinary and judicious firing.

As to the *weights* of the two classes of engines, that must depend somewhat upon what weight you can afford to give to your rail. For a fifty pound rail I would not use engines of more than twenty five tons (of 2,000 pounds) weight for passenger, and thirty tons for freight, and for sixty pound rail, thirty and thirty five tons respectively. These engines will draw up your steepest grades the heaviest passenger trains you are likely to have for some time, and freight trains of from three hundred and fifty to four hundred tons gross (that is, cars and load together), according to the weight of rail and engine you may use. These would be the performances of the machine when in perfect condition, although a less average duty would be realized from them in their ordinary every-day working order.

In estimating as above the performance of engines, I have assumed as your steepest grade one foot in one hundred, or 52 feet 8 inches per mile, and most abrupt curve 3 degrees, or 1,910 feet radius occurring on that grade.

The speed of express passenger trains may average twenty-five miles per hour inclusive of stops, reaching thirty or even thirty-five miles per hour on suitable parts of the road, and occasionally, to make up lost time, forty miles per hour would not be attended with danger if track and machinery are in good order. The speed of fast freight and stock trains may be fifteen miles per hour, including stops, with an extreme of twenty miles per hour running velocity at times. Trains with ordinary freight, and especially if carrying coal, ore, stone, lumber, and other heavy articles, should not average more than eight miles per hour, nor exceed twelve miles per hour under any circumstances.

I am aware that in recommending the connection of all the wheels of the locomotive for freight trains I differ from the popular idea upon most of the railways of the country, on which the engine with four or six drivers and a truck is mostly preferred. Until I can discover more clearly, however, the *principle* on which such preference is founded, I must adhere to my own views upon the subject. The usual reason given for coupling the *power* with only a *part* of the *weight* of the machine, which weight alone makes the power *effective*, is to save the *track*. However good this reason may be for high velocities, it does not apply to slow speeds with any material force, or at least not with sufficient to balance the advantage of increased effective power in the engine. If by uncoupling your front or your two front pairs of wheels you lose a fourth or a third-part of your adhesion, you must add a fourth or a third to the *number* of your engines, and in that proportion to the number of miles run to do the same work, thus increasing in nearly the same ratio the wear and tear of your track. It can scarcely be imagined that the increased smoothness of motion due to the substitution of the *truck* for the *drivers* will compensate for this increase, not only of wear and tear of road, but also of the other locomotive expenses.

I know, however, by experience, how difficult it is to settle such points by mere force of argument on general principles. *Facts* are the only arbitrators we can successfully appeal to, and I would therefore adduce a few to sustain my position. If the use of the connected engine did in fact produce greater wear and tear of track, we should see the result in the expense of maintaining it on those roads on which that kind of locomo-

tive is most employed. Let us look, then at the working of the four great east and west lines, viz., the New York Central, the Erie, the Pennsylvania Central, and the Baltimore & Ohio railroads; and, to bring the *last* fairly into the comparison, we will select the year 1860, before the war interrupted its business and inflated prices upon all the roads.

Now upon the New York Central there were no connected engines excepting such as may have been used at the stations in shifting trains; on the Erie there were but six out of two hundred and twenty, on the Pennsylvania Central, nineteen out of two hundred and eleven; on the Baltimore & Ohio, one hundred and forty seven out of two hundred and nineteen. From this it will be seen that upon all but the last of the four roads the transportation of freight was effected entirely, or almost entirely, by truck engines; while upon the last it was done almost altogether by connected engines. For the nineteen connected engines on the Pennsylvania Central and the six on the Erie were used only as *assistants* on the heaviest grades of those roads, while on the Baltimore & Ohio, after deducting forty-seven truck engines employed in the passenger business, there remained only twenty-five truck engines in the freight business, and they so inferior in weight and power to the one hundred and forty-nine connected engines as that these last may well be said to have done the whole freighting of the road. How, then, does the expense of maintenance of road and machinery compare on the four roads in that year (1860)? The published reports of the several companies show the following results;

NAME OF ROAD.	No. of Miles run.....	Track repairs per mile run.	Engine repairs per Mile run.	Engine & Car repairs per mile run.....	Total cost of working road per mile run
		cents.			
New York Central.....	4,493,213	19.80	9.06	17.90	95.22
Erie	3,474,917	24 13	9.01	20.7·	94.6¹
Pennsylvania Central.....	3,633,442	21.38	7.69	15.90	99 26
Baltimore & Ohio.....	3,831,295	15.90	6.78	15.44	51.79

Had the Reading Railroad been brought in, it would show its track repairs as 11.22 cents per mile run, and its engine repairs as 8.55 cents, and yet the Reading road does its entire slow freight and coal business with connected engines.

The year 1860 exhibits a fair average of preceding and succeeding years, and may therefore be safely taken as showing the effect of using this class of locomotive in the transportation of heavy freight as compared.

An inspection of the above comparative statement shows that the repairs of track as well as of engines alone and of engines and cars together, and also of the total cost of operating the road, are *less* upon the Baltimore & Ohio Railroad than upon any of the three others, notwithstanding that the grades and curves of that road are stronger than theirs, which, if the above mentioned objection to the connected engine were valid, should lead to a wholly different result. In truth the connected engine, whose front and back wheels only are flanged and also closer together than those of the truck engines, turn curves at slow speeds more easily than the latter, in consequence of these features in their construction.

The use of the connected engine and of heavy and powerful engines generally has been considered by many as advisable only on roads of high grades, or on the parts of roads where grades are high. It seems to be overlooked, however, that the relative performance of heavy and light engines, (comparing them only now as to their *available* or adhesive weight) will be nearly the same upon all grades; and hence, that if it is true economy to get all the power you can out of a locomotive on a grade of 100 feet per mile, it is no less wise to make the most of its power on a level grade. The Reading railway, which has no ascending grade in the direction in which its coal moves (except a short one on its Port Richmond Branch at Slutadelphia, where helping power is used), employs heavy connected engines altogether in its coal trade, and by the enormous trains drawn by these engines the cost of motive power is reduced to its minimum. The truck engine does not, it should be remarked, show as unfavorably in its power of draft alongside of the connected engine, in consequence of the free use of sand to promote adhesion; but this, it is plain, must increase the resistance to the movement of both the engine and train, and the wear of both wheels and rails, largely.

My reasons for preferring the eight-wheel connected engine are thus stated with, I hope, sufficient explicitness.

The Fairlie Engine "Tarapaca."

The distinguishing features of the Fairlie engine have already been so completely described in our pages, and we have on former occasions so fully explained the advantages attendant upon the employment of the double-bogie system, that there really remains but little for us to say on the matter unless we repeat statements already made. Notwithstanding, however, that the subject treated in the abstract may have become somewhat threadbare, there still remains to us the pleasant task of recording the advances made by Mr. Fairlie in bringing his system into practical use. For many years Mr. Fairlie has labored hard to get his views accepted by railway men, and knowing as we do that these views include many very important suggestions, we are glad to find that he is now making real headway, and that but a short time will elapse before the Fairlie system will have as full and complete a trial as Mr. Fairlie could possibly desire for it. Besides the engines on the Festiniog and the Neath & Brecon railways, with the performance of which our readers are familiar, and the engine for the Great Southern & Western of Ireland, already illustrated in our pages, there have been constructed within the last few months two Fairlie engines for Sweden, others are now being built for Russia, and last Friday we witnessed the trial at the Hatcham Works of the last engine turned out there, this engine—the "Tarapaca"—having been constructed for the Iquiqui Railway of Peru, a line of 4 ft. 8½ in. gauge, belonging to Messrs. Montero Brothers.

The "Tarapaca" is the largest engine yet constructed on the Fairlie system, and it is, indeed, one of the most powerful locomotives yet constructed on any plan whatever. It is carried on twelve 3 feet 6 in. wheels, arranged in two groups of three pairs each, the wheels of each group being coupled. Each of the bogies has a pair of 15 in. cylinders, with 20 in. stroke, and as the boiler pressure is sufficiently high to maintain an average effective pressure of about 100 pounds per square inch on the pistons, the tractive force which the engine is capable of exerting is 21,430 pounds, or about 9½ tons. The weight, in working order, is about 60 tons, so that there is ample adhesion even for this great cylinder power. The weight, we should mention, is equally distributed on the wheels.

The boiler is of the usual Fairlie type, and is fixed in the manner which has been adopted by Mr. Fairlie in all his later engines, it being entirely relieved of all strain due to the haulage of the train by the frames which connect the two bogies, and by which it is supported. The total length of the boiler is 31 feet 6 inches, there being two barrels, each 10 feet 6 inches in length, while the central space is taken up by the firebox casing. The firebox is divided at the middle of its length by a transverse midfeather, and it exposes in all a heating surface of 125 square feet, while the total tube-heating surface is 1,500 square feet, making a total surface of 1,625 square feet. The fire-grate area is 21 square feet. The engine has tanks carrying 2,200 gallons of water; and fuel bunkers holding 2 tons of coal, and the footplate, which is protected by awning, is of ample size. The general design of the engine is excellent, and notwithstanding its large size, there is nothing whatever about it suggestive of clumsiness, and much less of unwieldiness. On this point, however, our readers will have an opportunity of judging for themselves, as we intend to publish an engraving of the engine in an early number.

The "Tarapaca," capable as it is of exerting a tractive force of about 9½ tons, would easily haul on a level and at moderate speeds, a 2,000-ton train. On the Iquiqui Railway, however, there is an incline of 1 in 26 extending for a length of 11 miles, and it is this bank which the "Tarapaca" has been expressly constructed to work, the load which it is intended shall be taken up being trains of 150 tons. The work to be done may thus be approximately estimated as follows:

	lb.
Gravity of engine and train.....	18,092
Friction of engine at 18 lb. per ton.....	1,080
" train " 10 "	1,500
Total tractive force required	20,675

To exert this tractive force a mean effective pressure of about 97 lb. per square inch would be required in the cylinders, a pressure which we have no doubt could be maintained easily, as the speed during the ascent of the incline is not intended to be more than 11 or 12 miles per hour. At the last-mentioned speed, or 1,056 ft. per minute, the work to be done will amount to 20,672 × 1,056 =21,829,632 foot-pounds per minute, or over 661 horse power, no trifling power to be demanded of a locomotive engine.

The experimental line laid down in what is now generally known as the "cabbage garden," at Hatcham, consists of two semicircles of 50 ft. radius, united by pieces of straight line about 100 ft. in length. Round this ring the "Tarapaca" was on Friday last run with ease and perfect steadiness, the only approach to a check being that while traversing the curves the wheels were sometimes caught by the brake blocks. This, however, merely arose from there being insufficient clearance, the "Tarapaca" never having been intended to pass round curves of such exceptional sharpness as those at Hatcham, the sharpest curves on the Iquiqui Railway being of 800 ft. radius. Of the hauling power of the "Tarapaca" no trial could of course be made on the Hatcham "ring"—in fact, a train sufficient to develop the capabilities of such a locomotive would have extended eight times round the "ring" itself—but from the results obtained with other Fairlie engines there appears no reason to doubt that the "Tarapaca" will be found thoroughly up to its work, and that it will be the forerunner of many similar locomotives to be employed in situations where there is hard work to do.—*Engineering.*

The Craig Telegraph and The Western Union.

William Orton, President of the Western Union Telegraph Company publishes the following letter in *Tribune*, *Herald* and *World*, of New York:

More than a year ago the air in telegraphic circles suddenly became tremulous with whispered rumors of *A Great Discovery!* the results of which were destined to startle the world by an advance, at a single leap, as far beyond the achievements of Morse as were the latter over the Post Boy and Stage Coach. As the subject of these threatening hints and ominous insinuations began to emerge from the realms of the illimitable and to assume the faintest outline of prospective tangibility, it was discovered that this latest addition to the family of The Wonderful was an ancient member rejuvenated—well known twenty years ago as "The Automatic Telegraph." Only this and nothing more. It is now considerably more than half a year since Mr. D. H. Craig commenced the publication of that apparently infinite series of sonorous prophecies concerning the capacity of this venerable novelty, the latest chapter of which appeared in *The Herald* of Aug. 20. It is not my purpose even to attempt to catalogue the marvels which he has recorded as achieved. The object of this letter will be accomplished by referring briefly to a very few of them.

A telegraph line with one wire has been constructed between New York and Washington for the express purpose of demonstrating the voracious capacity of the long ago exploited idea. Of this line Mr. Craig says that it is "*more than 200 per cent superior to any of the lines of the Western Union Company;*" also, that he "can transmit, over a single wire, from Washington to New York, *twenty-four thousand words per hour!* which is equal to the average working of *more than thirty wires* by the Morse system of telegraphy!!" But as if these miracles were not enough to overwhelm with shame and mortification the "slow coaches" of the Western Union, who are compelled to employ the most skillful operators and the best telegraphic talent in the country, and, in fact, in the world, he mercilessly adds: "But the most important feature of our new system of telegraphy is its extreme simplicity and unerring accuracy. *A boy or girl of fifteen years of age can master the machinery and the whole system in a few hours!*"

Now the public are deeply interested in knowing whether these declarations are plain truths, or whether they are merely the gorgeous blossomings of a new speculation, whose golden fruit is only to be plucked by its "promoters," while the unfortunate stockholders solace themselves with the reflection that they are not the first who have "gone a wooling and come back shorn." Existing telegraph companies also are especially interested to know whether to go on putting up additional wires, in view of the danger that they may all be surpassed by this Telegraphic Paganini which is to accomplish all the possibilities of the electrical gamut on one string. The truth can be ascertained positively in a very simple manner, and I submit whether the newspaper department of the demonstration has not been carried far enough, and whether it is not time to stop ballooning and come down to business.

The function of the telegraph, as I understand it, is to convey a message from the sender to the party addressed in the shortest possible time. It cannot concern the *Tribune* to know that the electrical signals representing a special of 24,000 words, which its Washington correspondent wishes to forward at midnight, could be transmitted to New York in an hour, *after* "a boy or girl of 15 years of age" had spent 48 hours in punching a translation into the Morse characters through a strip of paper 2,000 feet long, and which would take 48 "children of larger growth" another hour in unraveling and copying from a labyrinth of paper of equal length at this end. What you require is the delivery of the special at your office before the *Tribune* goes to press, and I claim that this can be done more certainly and at less expense by the Morse system, or by the Phelps printing telegraph, than by any other.

To demonstrate my confidence as to the correctness of this opinion, and also to give Mr. Craig an opportunity to prove my ignorance and his superior knowledge, I offer the following:

Challenge.

The *Tribune*, *Herald* and *World* shall be, or shall appoint, a Committee of Three to arrange and superintend a trial between the one wire line and "fast" system of Mr. Craig, and one wire of the Western Union Company, from Washington to New York, each party to deposit with the Committee $1,000 to abide the result of the trial. The Committee shall cause to be delivered a dispatch in duplicate to Mr. Craig's line and the Western Union at Washington simultaneously, neither of the lines to have any previous knowledge of the contents of the dispatch, which may be in writing or printed, and must contain not less than 2,000 nor more than 3,000 words. The Western Union will use but one wire, and employ but two operators—one at each end, who shall not be changed or relieved during the trial. Mr. Craig shall be allowed *six operators*—three in Washington to prepare the transmit, and three at New York to receive, translate and copy the dispatch; and whichever party transmits, makes three legible copies, and first delivers them at the office of the *Tribune*, *Herald* and *World*, respectively, shall receive the $2,000. If awarded to the Western Union line, one half will be contributed to the fund for the Morse statue in Central Park, and the other half to the Telegraphers' Life Insurance Fund.

As a further guaranty of good faith on both sides, each party shall be permitted to have a representative in both the New York and Washington offices of the other party during the transmission and reception of the dispatch. Mr. Craig's line having but one wire, in the event of a break he would be unable to complete the test. To meet such a contingency, the Western Union will place at his disposal *two extra wires* so arranged that one of them may be substituted for his own in a few seconds.

This proposition, places one Western Union wire and two operators against Mr. Craig's "200 per cent. superior" wire and *six* operators for a test which must, I assume, occupy at least an hour. Until he accepts or declines, it is idle to waste words in discussion. And if he declines, as I fear he will, the public will not be likely to err in judgment concerning the merits of an alleged invention whose only achievement thus far consists in having out-trumpeted all competitors.

This offer will remain open for acceptance ten days, the trial to be made within 30 days thereafter. I am, very respectfully, &c., &c., WILLIAM ORTON.

Executive Office, Western Union Telegraph Co., Aug. 30, 1870.

—Only 48 years ago the late Mr. Joseph T. Buckingham, then editor of the Boston *Courier*, one of the most progressive of all the New England editors, wrote in his paper of June 27, 1827, as follows of the then talked-of railroad from Boston to Albany:

"Alcibiades, or some other great man of antiquity, it is said, cut off his dog's tail, that *quid nunc* (* * *) might not become extinct from want of excitement. Some such motive, we doubt not, moved one or two of our *natural* and experienced Philosophers to get up the project of a railroad from Boston to Albany—a project which every one knows, who knows the simplest rule in arithmetic—to be impracticable, but at an expense little less than the market value of the whole territory of Massachusetts; and which, if practicable, every person of common sense knows, would be as useless as a railroad from Boston to the moon."

RAIL AND WIRE.

BY THE AUTHOR OF "THE CLOUDS."

Rail and wire, by wheel and fire,
Plying hard their joint vocations,
As they sweep o'er land and deep,
Are bringing close the scattered nations.
Over land the iron steed
Swallows distance up in speed,
And the chariot of the sun
Is by courier wire outrun.
Albion speaks to Hindostan;
She replies, ere dove or swan
Could on swiftest pinion fly
From Isle of Wight to Isle of Skye.
Friction's drag is rent asunder,
Lightnings speak, but not in thunder;
Up they dash the breathless steep,
Down they dive into the deep.
Ocean bars the way no more,
Shore is linked to furthest shore;
And in weather fair or foul,
Talk together cheek by jowl.
Night no longer blocks the way,
Darkness works as well as day;
And while men and fishes sleep,
O'er the land, and through the deep,
Rush the fiery coursers on,
Swift as thought, and mute as stone:
Let us, then, with plaudits hail
Steam and lightning, wire and rail!

Wheel and wire, by steam and fire,
Are breaking up the whole foundations,
And blotting out the hate and doubt
Which kept apart the jealous nations.
Gates and walls are giving way,
Mountain range and briny bay
Ope their bosoms to embrace
Men of every clime and race.
Ancient laws are put to rout,
Which erewhile shut aliens out;
Boa-like, with fold on fold,
Clings the new around the old.
Commerce widens, traffic thickens,
Errors languish, knowledge quickens;
And by every conquest gained,
Other triumphs are attained.
One by one the scattered nations
Join in mutual ministrations—
East and West, and South and North,
Pour their special treasures forth.
Soon from pole to torrid zone
Earth one common board will own,
And Babel's curse be half forgot
When men shall speak in polyglot;
Let us, then, with welcome hail
Steam and lightning, wire and rail!

Rail and wheel, and wire and keel,
Are changing fast the old locations,
Nor will cease till pipes of peace
Are handed round to all the nations.
Men in troops the world are ranging,
Crafts and occupations changing,
Arts advancing, science, learning,
Enterprise new conquests earning;
And, as stones by streams are polished,
Old aversions are abolished.
Prejudice is giving way,
Reason reassumes its sway;
Power departs from cast and hue,
Customs old give place to new;
Yokes relax and cease to gall;
Fetters from the bondsmen fall.
Forced is pride, as best it can,
To own as man his fellow man;
And the nations strive to find
Fitting laws to guide mankind.
Bigotry conceals its ire,
Persecution damps his fire;
Truth is finding open door
Where the blind wall frowned before:
Let us, then, with welcome hail,
Steam and lightning, wire and rail!

A Want in Locomotive Engineering.

We this week saw in an English paper a controversy in regard to the speed of a train in rounding a curve, it being charged that a "driver," as our British cousins style a man who runs a locomotive, was in the habit of taking a particular train around a curve above the standard speed of forty miles an hour, for which the curves are calculated, thus endangering the safety of passengers.

This question of speed always comes up when accidents occur, and as yet no adequate means have been adopted whereby the precise speed of a locomotive engine at any given point of its running can be so recorded as to settle such questions beyond dispute.

Such an instrument would be a boon to engineers who run locomotives, and who are, in our opinion, much more often unjustly than justly blamed for undue and improper speed on the occasion of accidents.

The problem is not a difficult one to solve. We once, as a matter of personal amusement, designed an instrument on the principle of the ball governor which would do it perfectly. The balls, instead of being hung on pivoted arms, slid out on horizontal arms against scale-springs of definite power, as they revolved by motion derived by one of the truck wheels. In doing this they raised a tracing point along the side of a vertical cylinder revolving by clock-work, making a mark of given height for a given speed, rising with increased speed, and falling as the velocity of the locomotive decreased. Vertical lines on the surface of the cylinder represents hours and five minute divisions, and the position of the pointer between these lines might easily be computed for any less time than five minutes.

The general principle of this device is simply the conversation of rotary motion into pressure, and taking a diagram of the pressure at different points of motion, as is done with the steam indicator.

Doubtless inventors might greatly simplify this device, or it may be, adopting a different principle, succeed in devising something much better.

In legal actions arising from accidents on railways the corporations are always placed at a disadvantage before juries, the latter always being inclined to sympathize with the individuals rather than the companies, who, it is thought, can better afford to pay, than the individual can afford to fail to recover the damages he claims.

The witnesses, also, are, many of them, totally incompetent to judge of the question of speed, and are mostly liable to overrate it. The adoption of such an instrument as we have described, or some other calculated to effect the same object, would obviate all disagreements of this character, and thus prove valuable to the corporations, as well as to those who hold the responsible posts of engineers.—*Scientific American.*

The Railroad Combination.

The Buffalo *Commercial Advertiser*, commenting on the apprehension of those who fear that the combination of the trunk lines to New York will cause the permanent exaction of exorbitant rates, says:

We do not share in the apprehension thus expressed. When we first noticed the cessation of hostilities, as our readers will remember, we said it was very unlikely that any permanent alliance or practical combination of those great railways had been provided for. The agreement to stop a ruinous competition and attempt to do business on fair and conservative principles, did not warrant such a sweeping inference. It is very probable that the high contracting parties agreed to a division of the traffic which they had hitherto been fighting for, finding that the most feasible way of arriving at a desir able peace; but it is very unlikely that they perfected, or even attempted to perfect, arrangements for a practical consolidation of their interests.

As for the adoption of an oppressive tariff of freight or passenger rates, by the great trunk lines, we deem that a more unlikely contingency than the other. The passenger rates are limited by the law, in most of the States through which the lines pass; or, if they are not, so long as this State holds the New York Central to the rate of two cents a mile for first-class passengers, there can be no great oppression in that direction, for our law acts as a regulator to the whole passenger traffic between the East and the West. Freight rates, for the most important part of the year, are regulated by the great water routes. No combination of railways will increase the cost of water transit, and a wholesome competition is, therefore, always secure.

A Tribute to J. Edgar Thomson.

The following is an extract from a speech made at the celebration of the completion of the Lake Superior & Mississippi Railroad by its President, Wm. L. Banning, of St. Paul.

"But there is another whom I would wish to see here to-night; one whose friendship and confidances I am proud to acknowledge—who combines in an extraordinary degree the intelligence of the highly educated engineer with the broad and comprehensive views of the statesman. I need scarcely say I refer to J. Edgar Thomson, President of the Pennsylvania Railroad. I remember, in my frequent consultations with him, how he traced on the map the locality of the road, uniting the Mississippi river with the great inland sea; the course of the St. Lawrence and the chain of the Great Lakes, reaching to the very heart of the continent; the connections of the road with all the lines lines traversing the State westward, making it the highway for the products of our people; the route of the Northern Pacific; the shortest line from the lakes to the Pacific Ocean; his gigantic mind grasping the great problems with a readiness and sagacity born only of vast ability and great practical experience, which, joined to his world-wide reputation for integrity, inspired the necessary confidence to capitalists to furnish the means which have brought about this great achievement. And I well remember with generous frankness, when he was about to leave the city of Philadelphia for a long absence, he grasped my hand and said: "Draw on me for $40,000 to commence this work, and the balance shall be forthcoming." And thus the great enterprise was inaugurated.

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WANTED—By a practical steam fitter and engineer of considerable experience, a situation to run a stationary engine or as locomotive fireman. Inquire at this office.

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To Railroad Managers.

A Telegrapher of fifteen years' experience, now occupying a position as manager of an important telegraph office in the East, desires a position as superintendent or general manager of a railroad telegraph line in the West. Satisfactory references will be given as to qualifications and business ability. Applications may be made to the Editor of THE TELEGRAPHER, New York.

To Railroad Contractors!

LACLEDE & FORT SCOTT RAILROAD

SEALED PROPOSALS will be received at the office of the President, at Lebanon, Mo., until

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Proposals will be received for all or any part of the work.

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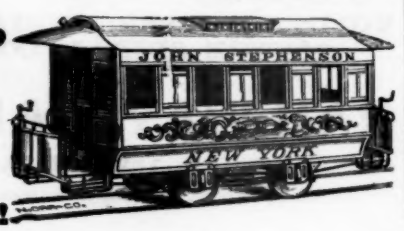

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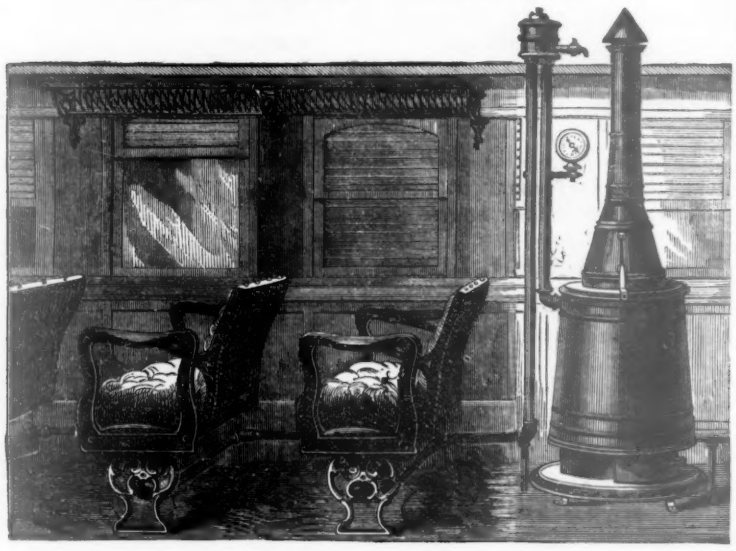

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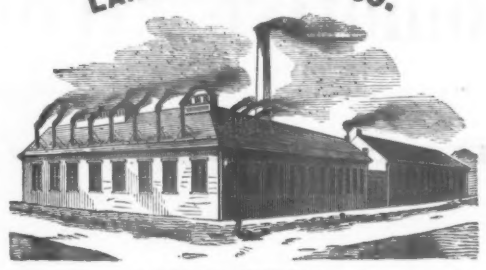

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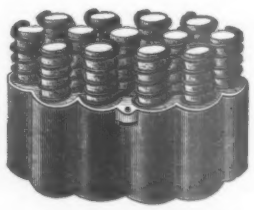

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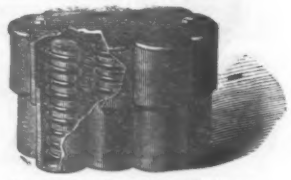

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15 Chamber of Commerce, Chicago.

New England M. M. Insurance Co., of Boston,
ASSETS $1,197,000.

Independent Insurance Company, - of Boston,
ASSETS $680,000.

North American Fire Ins. Co., of New York,
ASSETS $800,000.

Excelsior Fire Insurance Co., - - of New York,
ASSETS $340,000.

Fulton Fire Insurance Company, of New York,
ASSETS $400,000.

Home Insurance Company, - of Columbus, O.
ASSETS $515,000.

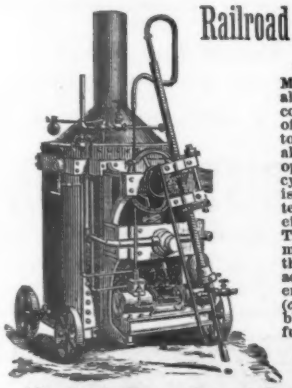
LESCHOT'S PATENT

DIAMOND POINTED

Steam Drills!

—FOR—

Railroad Grading, Well Boring, Prospecting, &c.

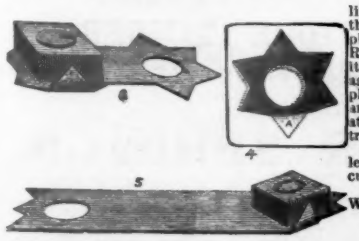


The unequalled efficiency and economy of these DRILLING MACHINES are fully established, and they are fast superseding all other inventions for **ROCK DRILLING.** They are constructed of various sizes and patterns to suit different classes of work, being adapted to Channelling and Gadding in quarries; to shafting, tunneling, prospecting and all open cut work in mines; also to heavy Railroad-grading and Sub-marine Blasting. They operate noiselessly without percussion; and produce a perfectly cylindrical hole of uniform diameter. Their usual rate of boring is three to five (3 to 5) inches per minute in hard rock; eight to ten (8 to 10) inches per minute in slate and sand rock, and eighteen to twenty-two (18 to 22) inches per minute in coal. TEST CORES, in the form of solid cylinders of rock or mineral may be taken out of mines from any depth—not exceeding one thousand (1,000) feet—showing the geological formation, character of mineral deposits, &c. These drills never need sharpening and no steel is consumed in boring—as the cutting points (*composed of rough, uncut diamonds,*) are practically indestructible. Boilers, Engines, Steam Pumps, and all necessary tools furnished with drills. Illustrated circular sent on application.

SEVERANCE & HOLT, Manufacturers,
Office, 16 Wall Street, New York

Office for the Western States at Eagle Works, 48 Canal St., Chicago. J. C. VINTON, Agent.

THE UNION PATENT STOP WASHER,



Manufactured at Coatesville, Chester Co., Pa., on the line of the Pennsylvania Central R. R., has now stood the test of practical use on the above road, the Philadelphia, Wilmington & Baltimore and Philadelphia & Reading Railroads, for the past two years, and proved itself to be what is claimed for it—a perfect security against the unscrowing or receding of nuts. Its simplicity, efficiency and cheapness over any other appliance for the purpose should recommend it to the attention of all persons having charge of Railroad tracks, cars and machinery.

It is especially adapted to, and extensively used by leading Railroads of the country for the purpose of securing nuts on railway joints.

The accompanying cuts show the application of the Washer. For further information, app to

A. GIBBONS, Coatesville, Pa.

THE

"RED LINE!"

—RUNNING OVER THE—

Michigan Southern and Lake Shore R. R.'s,

—WAS THE—

FIRST LINE to CARRY FREIGHT BETWEEN the EAST and WEST,

WITHOUT CHANGE OF CARS!

CARS RUN THROUGH TO

NEW YORK AND BOSTON,

IN FOUR AND FIVE DAYS!

☞ Contracts made at the Offices of the Line. ☜

C. Shutter, Agent, 247 Broadway, New York. A. Cushman, Agent, Old State House, Boston, Mass

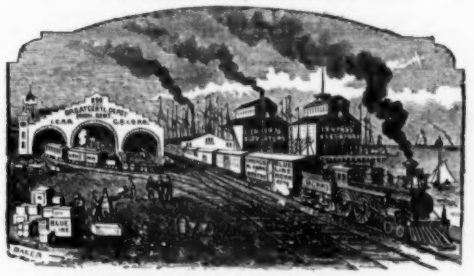
W. D. MANCHESTER, Agent, 54 Clark St., Chicago.

Great Central Route.

"BLUE LINE."

ORGANIZED JANUARY 1, 1867.

1870. 1870.



OWNED AND OPERATED BY THE

Michigan Central, Illinois Central, Chicago, Burlington & Quincy, Chicago & Alton, Great Western (of Canada), New York Central, Hudson River, Boston & Albany, and Providence and Worcester Railroads.

THE "BLUE LINE" is the only route that offers to shippers of freight the advantages of an unbroken gauge through from Chicago to the Seaboard, and to all Interior Points on the line of Eastern Connections beyond Suspension Bridge and Buffalo. All Through Freight is then transported between the most distant points of the roads in interest,

WITHOUT CHANGE OF CARS!

The immense freight equipment of all the roads in interest is employed, as occasion requires, for the through service of this Line, and has of late been largely increased. This Line is now prepared to extend facilities for the transit and delivery of all kinds of freight in Quicker Time and in Better Order than ever before.

The Blue Line Cars

are all of a solid, uniform build, thus largely lessening the chances of delay from the use of cars of a mixed construction, and the consequent difficulty of repairs, while remote from their own roads. The Blue Line is operated by the railroad companies who own it, without the intervention of intermediate parties between the Roads or Line and the public.

Trains run through with regularity **IN FOUR OR FIVE DAYS** to and from New York and Boston. Especial care given to the Safe and Quick Transport of Property Liable to Breakage or Injury, and to all **Perishable Freight.**

Claims for overcharges, loss or damage, promptly settled upon their merits. Be particular and direct all shipments to be marked and consigned via

"BLUE LINE."

☞ *FREIGHT CONTRACTS* given at the offices of the company in Chicago, New York and Boston.

J. D. HAYES, GEN. MANAGER,.. Detroit

C. E. NOBLE,.... } 349 Broadway, N. Y. | P. K. RANDALL, 69 Washington St., Boston
GEO. E. JARVIS,... } | W. W. STREET,.....91 Lake St., Chicago
N. D. MUNSON,.....Quincy, Ill. | J. JOHNSON,..... Cairo, Ill

THOS. HOOPS, GEN. FR'T AGT. Michigan Central Railroad, Chicago.
A. WALLINGFORD, AGT. M. C. & G. W. R. R., No. 91 Lake St., Chicago.
N. A. SKINNER, Freight Agent Michigan Central Railroad.

Empire Line.

THE EMPIRE TRANSPORTATION COMPANY'S

Fast Freight Line to the East

—AND—

TO THE COAL AND OIL REGIONS,

Via Michigan Southern, Lake Shore, and Philadelphia & Erie R. R.'s,

WITHOUT TRANSFER!

Office, No. 72 LaSalle Street, Chicago.

GEO. W. RISTINE, Western Superintendent, Cleveland, Ohio.

W. G. Van Demark,..265 Broadway, New York. | E. L. O'Donnell,.....Baltimore, Md
G. B. McCulloh,....42 South 5th St., Philadelphia. | Wm. F. Smith,.....Erie, Penn

JOHN WHITTAKER, Pier 14 North River, New York.

JOSEPH STOCKTON, Agent, Chicago.

W. T. HANCOCK, Contracting Agent.
WM. F. GRIFFITTS, Jr., Gen. Freight Agent, Philadelphia.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

☞ THE DIRECT ROUTE FOR ☜

JOLIET, MORRIS, OTTAWA, LASALLE, PERU, HENRY, PEORIA,

Lacon, Geneseo, Moline,

ROCK ISLAND, DAVENPORT,

Muscatine, Washington, Iowa City,

GRINNELL, NEWTON, DES MOINES,

COUNCIL BLUFFS & OMAHA!

CONNECTING WITH TRAINS ON THE UNION PACIFIC RAILROAD, FOR

Cheyenne, Denver, Central City, Ogden, Salt Lake, White Pine, Helena, Sacramento, San Francisco,

And Points in Upper and Lower California; and with Ocean Steamers at San Francisco, for all Points in **China, Japan, Sandwich Islands, Oregon and Alaska.**

☞ TRAINS LEAVE their Splendid new Depot, on VanBuren Street, Chicago, as follows:

	LEAVE.	ARRIVE.
PACIFIC EXPRESS, (Sunday excepted)	**10.00 a. m.**	3.35 p. m
PERU ACCOMMODATION, (Sundays excepted)	5.00 p. m.	9.50 a. m
PACIFIC EXPRESS, (Saturdays excepted,)	10.00 p. m.	[Mon. ex. 6.00 a. m

ELEGANT PALACE SLEEPING COACHES!

Run Through to Peoria and Council Bluffs, Without Change.

☞ Connections at LA SALLE, with Illinois Central Railroad, North and South; at PEORIA, with Peoria, Pekin & Jacksonville Railroad, for Pekin, Virginia, &c.; at PORT BYRON JUNCTION, for Hampton, LeClaire, and Port Byron; at ROCK ISLAND, with Packets North and South on the Mississippi River.

☞ **For Through Tickets,** and all desired information in regard to Rates, Routes, etc., call at the Company's Offices, No. **37** South Clark Street, Chicago, **413** California Street, San Francisco, or **257** Broadway, New York.

A. M. SMITH, Gen. Pass. Agent. HUGH RIDDLE, Gen. Supt. P. A. HALL, Asst. Gen. Supt.

Leavenworth, Lawrence,

— AND —

GALVESTON R. R. LINE,

OF KANSAS.

Two Distinct Lines of Road from Kansas City, Mo., and Lawrence, Kan.,

Uniting at OTTAWA, and from thence as a Trunk Line to

INDIAN TERRITORY.

The SHORTEST and ONLY DIRECT ROUTE to the celebrated Neosho and Verdigris Valleys of Kansas, and will be opened for business to the Border of Indian Territory, by Nov. 1st, 1870.

☞ **FIVE DAILY TRAINS, Each Way,** connecting at LAWRENCE with trains the KANSAS PACIFIC ROAD, for WEST and NORTH and at KANSAS CITY with ALL ROADS FOR THE EAST and NORTH, at end of Track with KANSAS STAGE CO.'S LINE OF COACHES for all parts of

INDIAN TERRITORY, TEXAS & NEW MEXICO.

☞ **Ask for Tickets via L. L. & G. R. R.,** for all points in Southern Kansas. Freight taken from any part of the East to end of track WITHOUT BREAKING BULK.

CHAS. B. PECK, Gen. Freight and Ticket Agent, Lawrence, Kan.

M. R. BALDWIN, Superintendent, Lawrence, Kan.

CHAS. J. PUSEY, **P. O. Address—Box 5222.** EDW'D H. PARDEE.

Pusey & Pardee,

74 BROADWAY, NEW YORK.

American and English Rails,

LOCOMOTIVES AND CARS FISH-PLATES, SPIKES, &c.

—SOLE AGENTS FOR—

Atkins Brothers' Pottsville Rolling Mills, and G. Buchanan & Co., of London.

☞ Special attention given to filling orders for small T and **STREET RAILS,** of every weight and pattern.

OLD RAILS BOUGHT OR RE-ROLLED, AS DESIRED.

J. E. FRENCH. W. S. DODGE. D. W. CROSS.

Winslow Car Roofing Company.

PATENT IRON CAR ROOFS.

Established, 1859.

No. 211 Superior St. CLEVELAND, O.

Over 20,000 Cars covered with this Roof! We claim that these Roofs will keep Cars dry, and will last as long as the Cars they cover without any extra expense after once put on.

☞ SEND FOR CIRCULARS.

Milwaukee & St. Paul R. W.

THE ONLY ALL RAIL LINE TO

ST. PAUL AND MINNEAPOLIS!

AND ALL PORTIONS OF

Wisconsin, Minnesota & Northern Iowa.

PURCHASE TICKETS VIA MILWAUKEE.

Passengers Going via Milwaukee,

Have Choice of Seats in Clean Coaches, and on Night Trains, a full night's rest in Palace Sleeping Cars.

☞ BAGGAGE CHECKED THROUGH BY THIS ROUTE ONLY! ☜

PASSENGERS FROM CHICAGO can obtain these Advantages only by the MILWAUKEE DIVISION of the CHICAGO & NORTHWESTERN R'Y.

SPECIAL NOTICE.—Passengers destined to any place in Wisconsin, Minnesota, or Northern Iowa, either on or off the Lines of this Company, who cannot procure Through Tickets to their destination, should purchase their Tickets **TO MILWAUKEE,** as this is the Great Distributing Point for these States.

A. V. H. CARPENTER, Gen. Pass. Agt. Milwaukee.

S. S. MERRILL, Gen. Manager, Milwaukee.

KANSAS PACIFIC RAILWAY.

Great Smoky Hill Route,

Now Completed and Open for Business Through to

DENVER, COLORADO,

There Connecting with the DENVER PACIFIC RAILROAD for CHEYENNE, forming, in Connection with the UNION and CENTRAL PACIFIC RAILROADS, another ALL-RAIL ROUTE to

CALIFORNIA, NEVADA, UTAH, MONTANA

WYOMING, COLORADO, &C.

The most available Passenger and Freight Route to Lawrence, Topeka, Junction City, Abilene, Salina, Hays, KIT CARSON, River Bend, DENVER, CHEYENNE, OGDEN, SALT LAKE CITY,

Sacramento, and San Francisco.

☞ Close Connections are made in Union Depots at KANSAS CITY and STATE LINE with Express Trains of the HANNIBAL & ST. JOSEPH, NORTH MISSOURI and MISSOURI PACIFIC RAILROADS.

Southern Overland Passenger and Mail Coaches leave Kit Carson daily for Pueblo, Trinidad, Fort Union, Santa Fe, &c.

Hughes & Co.'s Splendid Concord Coaches leave Denver daily for Central City, Georgetown, &c.

Passenger and Freight Rates always as low and conveniences as ample as by any other Route.

PULLMAN'S PALACE CARS ACCOMPANY NIGHT EXPRESS TRAINS.

Through Tickets can be obtained at all principal ticket offices. Be careful to ask for tickets via Kansas Pacific Railway, "Smoky Hill Route."

5,000,000 Acres of Farming Lands For Sale!

Situated along the line of this Great National Railway. For particulars, address JNO. P. DEVEREUX, Land Commissioner, Lawrence, Kansas.

R. B. GEMMELL, Gen. Freight & Ticket Agt. **A. ANDERSON, Gen. Supt.**

THE ERIE & PACIFIC DISPATCH CO.

Are Authorized Freight Agents.

For information, Contracts, and Bills of Lading, apply at their office, **64** Clark Street, Chicago.

H. H. RAPP, AGT.

MARSH & GOODRIDGE.
256 SOUTH WATER ST. CHICAGO.

Dealers in

R. R. Cross-Ties, Telegraph Poles,

FENCE POSTS, BRIDGE TIMBER,

Piles, Hard-wood Plank, &c., &c.,

To which the Attention of Railroad Contractors and Purchasing Agents is respectfully called.

REFER TO:—Jas. M. Walker, Chicago, Pres't L. L. & G. R. R.; Jas. E. & Wm. Young, Chicago, Railroad Builders; H. J. Higgins, Purchasing Agent C. B. & Q. R. R.; and Railroad Officers and Purchasing Agents generally.

MARSH & GOODRIDGE,

256 South Water St., Chicago.

CHICAGO & NORTHWESTERN R. W.

Comprising the PRINCIPAL RAILROADS from CHICAGO Directly NORTH NORTH-WEST and WEST.

ALL RAIL TO THE PACIFIC OCEAN!

Great California Line.

TRAINS LEAVE WELLS STREET DEPOT AS FOLLOWS:

8:15 A. M. Cedar Rapids Pass | **9:15 P. M.** Night Mail.
10:30 A. M. Pacific Express. | **9:15 P. M.** Rock Island Pass.
10:30 A. M. Rock Island Exp. | **4:00 P. M.** Dixon Passenger.

For Sterling, Rock Island, Fulton, Clinton, Cedar Rapids, Boone, Denison, Missouri Valley Junction, Sioux City, Council Bluffs and Omaha, there connecting with the

UNION PACIFIC R. R.

For Cheyenne, Denver, Ogden, Salt Lake, the White Pine Silver Mines, Sacramento, San Francisco, and all parts of Nebraska, Colorado, New Mexico, Arizona, Wyoming, Montana, Idaho, Utah, Nevada, and the PACIFIC COAST.

FROM CHICAGO	Hours.	1st Class Fare.	FROM CHICAGO	Days.	1st Class Fare.
To OMAHA,.....	23	$20.00	To SACRAMENTO,.	4½	$118.00
" DENVER,.....	52	70.75	" SAN FRANCISCO,	5	118.00

TRAINS ARRIVE:—Night Mail, **7.00** a. m.; Dixon Passenger, **11.10** a. m.; Pacific Express, **3:50** p. m.; Rock Island Express, **3:50** p. m.; Cedar Rapids Passenger, **6:50** p. m.

FREEPORT LINE.

9.00 A. M. & 9.45 P. M. For Belvidere, Rockford, Freeport, Galena, Dunleith, and St. Paul.
4.00 P. M., Rockford Accommodation.
5.30 P. M., Geneva and Elgin Accommodation
6.10 P. M., Lombard Accommodation.
5:50 P. M., Junction Passenger.

TRAINS ARRIVE:—Freeport Passenger, **2:30** a. m., **3:00** p. m.; Rockford Accommodation, **11:10** a. m.; Geneva and Elgin Accommodation, **8:45** a. m.; Junction Passenger, **8:10** a. m.; Lombard Accommodation, **6:50** a. m.

WISCONSIN DIVISION.

☞ Trains leave Depot, cor. West Water and Kinzie Sts., daily, Sundays excepted, as follows:

10.00 A. M. **DAY EXPRESS,** for Janesville, Monroe, Whitewater, Madison, Prairie du Chien, Watertown, Minnesota Junction, Portage City, Sparta, La Crosse, St. Paul, and ALL POINTS ON THE UPPER MISSISSIPPI RIVER; Ripon, Berlin, Fond du Lac, Oshkosh, Neenah, Appleton, and Green Bay.
3.00 P. M., Janesville Accommodation.
5.00 P. M. **NIGHT EXPRESS,** for Madison, Prairie du Chien, Watertown, Minnesota Junction, Portage City, Sparta, La Crosse, St. Paul, and ALL POINTS ON THE UPPER MISSISSIPPI RIVER; Ripon, Berlin, Fond du Lac, Oshkosh, Menasha, Appleton, Green Bay, and THE LAKE SUPERIOR COUNTRY.
5.30 P. M., Woodstock Accommodation.
6:20 P. M., Barrington Passenger.

TRAINS ARRIVE:—**5:30** a. m., **7:45** a. m., **10:10** a. m., **1:00** p. m. and **7:15** p. m.

MILWAUKEE DIVISION.

MILWAUKEE MAIL,	**8:00 A. M.**
EXPRESS, (ex. Sun.) Waukegan, Kenosha, Racine and Milwaukee,	**9:45 A. M.**
EVANSTON PASSENGER,	**5:00 P. M.**
HIGHLAND PARK PASSENGER,	**11:40 A. M.**
MILWAUKEE ACCOMMODATION, with Sleeping Car attached	**1:15 P. M.**
EVANSTON ACCOMMODATION, (Daily,) from Wisconsin Div. Depot	**11:00 P. M.**
KENOSHA ACCOMMODATION, (Sundays excepted) from Wells St. Depot	**1:30 P. M.**
AFTERNOON PASSENGER, from Milwaukee Div. Depot	**4:15 P. M.**
WAUKEGAN ACCOMMODATION, (except Sundays) from Wells St. Depot	**5:00 P. M.**
WAUKEGAN PASSENGER, (Sundays excepted) from Wells St. Depot	**5:25 P. M.**
	6:15 P. M.

TRAINS ARRIVE:—Night Accommodation, with Sleeping Car, **5:00** a. m.; Day Express, **4:10** p. m. Milwaukee Mail, **10:10** a. m.; Afternoon Passenger, **8:00** p. m.; Waukegan Accommodation, **8:25** a. m.; Kenosha Accommodation, **9:10** a.m.; Evanston Accommodations, **1.40** and **4.00** p. m.; Waukegan Passenger, **7:55** a. m.; Highland Park Passenger, **3.45** p. m.

PULLMAN PALACE CARS ON ALL NIGHT TRAINS.

THROUGH TICKETS Can be purchased at all principal Railroad Offices East and South, and in Chicago at the Southeast corner of Lake and Clark Streets, and at the Passenger Stations as above.

H. P. STANWOOD, Gen. Ticket Agt.
GEO. L. DUNLAP, Gen'l Supt.

Western Union Railroad.

CHICAGO & NORTHWESTERN DEPOT, CHICAGO. | MILWAUKEE & CHICAGO DEPOT, MILWAUKEE.

THE DIRECT ROUTE!

CHICAGO, RACINE & MILWAUKEE,

— TO —

Beloit, Savanna, Clinton, Pt. Byron, Davenport, Mineral Point, Madison, Freeport, Fulton, Lyons, Rock Island, Sabula, Galena, Dubuque, Des Moines, Council Bluffs,

OMAHA, SAN FRANCISCO

AND ALL PRINCIPAL POINTS IN

Southern and Central Wisconsin, Northern Illinois, and Central and Northern Iowa.

FRED. WILD, Gen. Ticket Agent.
D. A. OLIN, Gen. Superintendent.

CRERAR, ADAMS & CO.,

MANUFACTURERS AND DEALERS IN

Railroad Supplies!

—AND—

CONTRACTORS' MATERIAL.

11 and 13 Wells Street,

CHICAGO, ILL.

Manufacturers of IMPROVED HEAD-LIGHTS for Locomotives, Hand and Signal Lanterns, Car and Station Lamps, Brass Dome Casings, Dome Mouldings, Cylinder Heads, and Car Trimmings, of Every Description.

Pan-Handle

—AND—

Penn'a Central Route East!

☞ SHORTEST AND QUICKEST ROUTE, VIA COLUMBUS, TO ☜

PITTSBURGH, BALTIMORE, PHILADELPHIA & NEW YORK

On and after Saturday, JULY 10th, 1870, Trains for the East will run as follows:

[DEPOT CORNER CANAL AND KINZIE STS., WEST SIDE.]

8:10 A. M. DAY EXPRESS. [SUNDAYS EXCEPTED.] Via Richmond. Arriving at

COLUMBUS....	2:35 A. M.	HARRISBURG..	10:35 P. M.	NEW YORK....	6:40 A. M.
PITTSBURGH..	12:00 M.	PHILADELPHIA	3:10 A. M.	BALTIMORE....	2:30 A. M.
WASHINGTON..	5:50 A. M.	BOSTON.....	5:05 P. M.		

7:40 P. M. NIGHT EXPRESS. [SATURDAYS EXCEPTED.] Arriving at:

COLUMBUS...	11:15 A. M.	HARRISBURG..	5:10 A. M.	NEW YORK...	12:10 P. M.
PITTSBURGH..	7:05 P. M.	PHILADELPHIA	9.35 A. M.	BALTIMORE...	9:00 A. M.
WASHINGTON.	1:10 P. M.	BOSTON.....	11:30 P. M.		

Palace Day and Sleeping Cars

Run Through to COLUMBUS, and from Columbus to NEW YORK, WITHOUT CHANGE!

ONLY ONE CHANGE TO NEW YORK, PHILADELPHIA, OR BALTIMORE!

CINCINNATI & LOUISVILLE AIR LINE SOUTH.

42 Miles the Shortest Route to Cincinnati,
18 Miles the Shortest Route to Indianapolis and Louisvill .

—FROM ONE TO—

2 Hours the Quickest Route to Cincinnati!

THE SHORTEST AND BEST ROUTE TO

Columbus, Chillicothe, Hamilton, Wheeling, Parkersburg, Evansville, Dayton, Zanesville, Marietta, Lexington, Terre Haute, Nashville,

ALL POINTS IN CENTRAL & SOUTHERN OHIO, & INDIANA, KENTUCKY & VIRGINIA.

— QUICK, DIRECT AND ONLY ALL RAIL ROUTE TO —

New Orleans, Memphis, Mobile, Vicksburg, Charleston, Savannah,

AND ALL POINTS SOUTH.

Cincinnati, Indianapolis and Louisville Trains run as follows:

THROUGH WITHOUT CHANGE OF CARS!

8:10 A. M. (Sundays excepted) Arriving at		**7:40 P. M.** (Saturdays excepted.) Arriving at	
LOGANSPORT	1:15 P. M.	LOGANSPORT	1:30 A. M.
KOKOMO	2:33 P. M.	KOKOMO	2:45 A. M.
CINCINNATI	9:30 P. M.	CINCINNATI	10:30 A. M.
INDIANAPOLIS	5:00 P. M.	INDIANAPOLIS	5:40 A. M.
LOUISVILLE	11:30 P. M.	LOUISVILLE	3:50 P. M.

Lansing Accommodation: Leaves 5:10 P. M. Arrives 8:55 A. M.
Dolton Accommodation: Leaves 10:10 A. M. Arrives 3:25 P. M.

PULLMAN'S PALACE SLEEPING CARS!

Accompany all Night Trains between Chicago and Cincinnati or Indianapolis.

☞ Ask for Tickets via **COLUMBUS** for the East, and via **"The AIR LINE"** for Cincinnati, Indianapolis, Louisville and points South. Tickets for sale and Sleeping Car Berths secured at **95 RANDOLPH STREET, CHICAGO,** and at Principal Ticket Offices in the West and Northwest.

WM. L. O'BRIEN, Gen. Pass. and Ticket Agent, Columbus.
I. S. HODSDON, Northwestern Pass. Agt., Chicago.

D. W. CALDWELL Gen Supt. Columbus.

MOORE
Steel Elastic Car Wheel Co.

OF NEW JERSEY.

Proprietors of

MOORE'S PATENT

FOR THE MANUFACTURE OF

ELASTIC CAR WHEELS.

FOR PASSENGER AND SLEEPING COACHES.

Noiseless, Safe, Durable and Economical.

Also, Manufacturers of

CAR WHEELS OF EVERY DESCRIPTION.

H. W. MOORE, President.
JAS. K. FROTHINGHAM, Secretary.
F. W. BLOODGOOD, Treasurer.

Works, cor. Green and Wayne Sts., JERSEY CITY, N. J.
P. O. Address—Box 129, Jersey City, N. J.

American Compound Telegraph Wire.

More than 3000 Miles now in Operation,

Demonstrating beyond question its superior working capacity, and great ability to withstand the elements. For RAILROAD LINES, connecting a single wire with a large number of Stations, and for long circuits, this wire is peculiarly adapted; the large conducting capacity secured by the copper, with other advantages, rendering such lines fully serviceable during the heaviest rains.

Having a core of steel, a small number of poles only are required, as compared with iron wire construction, thereby preventing much loss of the current from escape and very materially reducing cost of maintenance. OFFICE AMERICAN COMPOUND TELEGRAPH WIRE CO.
234 West 29th Street, New York.

BLISS, TILLOTSON & CO., Western Agents,
247 South Water Street, Chicago.

THE FAVORITE THROUGH PASSENGER ROUTE!

Chicago, Burlington & Quincy
RAILROAD LINE.

3 THROUGH EXPRESS TRAINS DAILY!

FROM CHICAGO	Hours.	1st Class Fare.	FROM CHICAGO	Days.	1st Class Fare.
TO OMAHA,	23	$20.00	TO DENVER,	2¼	$68.70
" ST. JOSEPH,	21	19.50	" SACRAMENTO,	4½	118.00
" KANSAS CITY,	22	20.00	" SAN FRANCISCO,	5	118.00

TRAINS LEAVE CHICAGO from the Great Central Depot, foot of Lake Street, as follows:

BURLINGTON, KEOKUK, COUNCIL BLUFFS & OMAHA LINE.

7:40 A. M. MAIL AND EXPRESS, (Except Sunday,) stopping at all stations; making close connections at Mendota with Illinois Central for Amboy, Dixon, Freeport, Galena, Dunleith, Dubuque, LaSalle, El Paso, Bloomington, &c.

10:45 A. M. PACIFIC FAST LINE, (Except Sunday,) stopping at Riverside, Hinsdale, Aurora, Leland, Mendota, Princeton, Buda, Kewanee, Galva, Galesburg, and all Stations West and South of Galesburg.

☞ An ELEGANT DAY COACH and a **PULLMAN PALACE DRAWING ROOM CAR** is attached to this train daily from Chicago

TO COUNCIL BLUFFS & OMAHA WITHOUT CHANGE!

5.00 P. M. EVENING EXPRESS, (Daily, except Sunday), in direct connection with the celebrated New York and Chicago Lightning Express Trains of all Eastern Lines, for Burlington, Ottumwa, Des Moines, Nebraska City, Council Bluffs, Omaha, and all points West. **Pullman Drawing-Room Sleeping Car** attached to this Train daily from **Chicago to Ottumwa without change!**

11:30 P. M. NIGHT EXPRESS, (Daily, except Saturday,) stopping at all principal Stations between Chicago and Burlington. ELEGANT DAY COACHES, and a **PULLMAN PALACE SLEEPING CAR** are attached to this train from **Chicago to Burlington, without change!** This is the only Route between

CHICAGO, COUNCIL BLUFFS & OMAHA,

— RUNNING THE CELEBRATED —

Pullman Palace Dining Cars!

49 MILES THE SHORTEST ROUTE BETWEEN

Chicago & Keokuk,

And the Only Route Without Ferrying the Mississippi River!

QUINCY, ST. JOSEPH, LEAVENW'TH & KANSAS CITY LINE.

10:45 A. M. PACIFIC EXPRESS, (Daily, except Sunday,) with an Elegant Day Coach and one of PULLMAN'S PALACE SLEEPING CARS attached, running through from Chicago to KANSAS CITY, **Without Change!**

5:00 P. M. EVENING EXPRESS, (Daily, except Sunday,) with **Pullman Palace Drawing Room Sleeping Car** attached, running through from Chicago to QUINCY, WITHOUT CHANGE!

11:30 P. M. NIGHT EXPRESS (Daily, except Saturday,) with **Pullman Palace Sleeping Car** attached from Chicago to GALESBURG; PALACE DAY COACHES from Chicago to QUINCY, **Without Change!**

64 MILES THE SHORTEST AND ONLY ROUTE BETWEEN

Chicago and Kansas City!

WITHOUT CHANGE OF CARS OR FERRY.

115 MILES The Shortest Route bet. Chicago & St. Joseph.

THE SHORTEST, BEST AND QUICKEST ROUTE BETWEEN CHICAGO AND

Atchison, Weston, Leavenworth, Lawrence,

AND ALL POINTS ON THE KANSAS PACIFIC R'Y.

Local Trains Leave { RIVERSIDE & HINSDALE ACCOMMODATION, 7:00 A. M. 1:30 & 6:15 P. M. / MENDOTA PASSENGER ..... 4:15 P. M. / AURORA PASSENGER ..... 5:30 P. M.

Trains Arrive:—Mail and Express, 3:45 p. m.; Atlantic Exp., 4:15 p. m., except Sunday; Night Exp. 9:05 a. m., except Monday; Mendota Passenger, 10:00 a. m.; Aurora Passenger, 8:15 a. m.; Quincy Passenger 7:30 P. M.; Riverside and Hinsdale Accommodation, 6:50 and 9 a. m. and 5:30 p. m., except Sunday.

Ask for Tickets via Chicago, Burlington & Quincy Railroad, which can be obtained at all principal offices of connecting roads, and at Company's office in Great Central Depot, Chicago, at as low rates as by any other route.

ROB'T HARRIS, Gen'l Superintendent, CHICAGO.
SAM'L POWELL, Gen'l Ticket Agent, CHICAGO.
E. A. PARKER, Gen. West. Pass. Agt., CHICAGO

THE GREAT THROUGH PASSENGER ROUTE TO KANSAS

IS VIA THE OLD RELIABLE

HANNIBAL & ST. JOSEPH
SHORT LINE.

Crossing the Mississippi at Quincy and the Missouri at Kansas City on New Iron Bridges; running Three Daily Express Trains, Through Cars and Pullman Sleeping Palaces from Chicago & Quincy to St. Joseph & Kansas City.

The Advantages gained by this Line over any other Route from Chicago, are:

115 MILES THE SHORTEST!

To St. Joseph, Atchison, Hiawatha, Waterville, Weston, Leavenworth,

64 MILES THE SHORTEST!

To Kansas City, Fort Scott, Lawrence, Ottawa,

Garnett, Iola, Humboldt, Topeka, Burlingame, Emporia, Manhattan, Fort Riley, Junction City, Salina, Ellsworth, Hays, Sheridan, Olathe, Paola, Cherokee Neutral Lands, Baxter Springs, Santa Fe, New Mexico, and all Points on the KANSAS PACIFIC, and MISSOURI RIVER, FT. SCOTT & GULF R. R's, with which we connect at Kansas City Union Depot.

THIS BEING THE SHORTEST LINE AND QUICKEST, is consequently the cheapest; and no one that is posted thinks of taking any other Route from Chicago to reach principal points in

Missouri, Kansas, Indian Territory, or New Mexico.

DAILY OVERLAND STAGES from west end Kansas Pacific Railway, for Pueblo, Santa Fe, Denver, and points in Colorado and New Mexico.

This is also a most desirable Route, via St. Joseph, to Brownsville, Nebraska City, Council Bluffs, and Omaha, connecting with the Union Pacific Railroad for Cheyenne, Denver, Salt Lake, Sacramento, San Francisco, and the Pacific coast.

Through Tickets for Sale at all Ticket Offices. Baggage Checked Through, and Omnibus Transfers and Ferriage avoided.

P. B. GROAT, Gen. Ticket Agent. HANNIBAL, MO.
GEO. H. NETTLETON, Gen. Supt. HANNIBAL, MO.

Old, Reliable, Air-Line Route!

CHICAGO, ALTON & ST. LOUIS R. R.

SHORTEST, QUICKEST AND ONLY DIRECT ROAD TO

Bloomington, Springfield, Jacksonville, Alton,

— AND —

ST. LOUIS!

WITHOUT CHANGE OF CARS.

THE ONLY ROAD MAKING IMMEDIATE CONNECTIONS AT ST. LOUIS, WITH MORNING AND EVENING TRAINS

— FOR —

ATCHISON, LEAVENWORTH, KANSAS CITY,

Lawrence, Topeka, Memphis, New Orleans,

And All Points South and Southwest.

☞ TRAINS leave CHICAGO from the West-side Union Depot, near Madison Street Bridge. ☜

EXPRESS MAIL, [Except Sundays]	8:10 A. M.
LIGHTNING EXPRESS, [Except Saturdays and Sundays]	9:50 P. M.
NIGHT EXPRESS, [Daily]	6:00 P. M.
JOLIET ACCOMMODATION, [Except Sundays]	4:40 P. M.
JACKSONVILLE EXPRESS, [Daily]	6:00 P. M.

Trains arrive at Chicago at 8.00 P. M., 8.30 A. M. and 6:00 A. M. Joliet Accom., 9.40 A. M.

This is the ONLY LINE Between CHICAGO & ST. LOUIS RUNNING

Pullman's Palace Sleeping and Celebrated Dining Cars!

BAGGAGE CHECKED THROUGH.

Through Tickets can be had at the Company's office, No. 55 Dearborn street, Chicago, or at the Depot, corner of West Madison and Canal streets, and at all principal Ticket Offices in the United States and Canada. Rates of Fare and Freights as low as by any other Route.

A. NEWMAN, Gen. Pass. Agent. **J. C. McMULLIN, Gen. Supt.**

North Missouri R. R.

PASSENGERS FOR

KANSAS AND THE WEST,

ARE REMINDED THAT

THE NORTH MISSOURI R. R.

— IS —

11 MILES SHORTER than any other Route!

BETWEEN

St. Louis and Kansas City.

15 Miles Shorter between ST. LOUIS and LEAVENWORTH

— AND —

49 MILES SHORTER TO ST. JOSEPH!

THAN ANY OTHER LINE OUT OF ST. LOUIS.

☞ **Three Through Express Trains Daily!** ☜

Pullman's Celebrated Palace Sleeping Cars on all Night Trains!

☞ **FOR TICKETS,** apply at all Railroad Ticket Offices, and see that you get your Tickets via St. Louis and North Missouri Railroad.

C. N. PRATT, Gen. Eastern Agt., 111 Dearborn-st. CHICAGO.
S. H. KNIGHT, Gen. Superintendent, ST. LOUIS.

JAS. CHARLTON, Gen. Pass. and Ticket Agt., St. Louis.

Pacific Railroad of Missouri.

THE MOST DIRECT AND RELIABLE ROUTE FROM ST. LOUIS THROUGH TO

KANSAS CITY, LEAVENWORTH & ATCHISON,

☞ WITHOUT CHANGE OF CARS! ☜

Close Connections at KANSAS CITY with Missouri Valley, Missouri River, Ft. Scott & Gulf, and Kansas Pacific R'ys, for Weston, St. Joseph, Junction City, Fort Scott, Lawrence, Topeka, Sheridan, Denver, Fort Union, Santa Fe, and

ALL POINTS WEST!

☞ At SEDALIA, WARRENSBURG and PLEASANT HILL, with Stage Lines for Warsaw, Quincy, Bolivar, Springfield, Clinton, Osceola, Lamar, Carthage, Granby, Neosho, Baxter Springs, Fort Gibson, Fort Smith, Van Buren, Fayetteville, Bentonville.

PALACE SLEEPING CARS on all NIGHT TRAINS.

Baggage Checked Through Free!

THROUGH TICKETS for sale at all the Principal Railroad Offices in the United States and Canadas. **Be Sure and Get your Tickets over the PACIFIC R. R. OF MISSOURI.**

W. B. HALE, Gen. Pass. and Ticket Agt.
THOS. McKISSOCK, General Superintendent.

THREE HOURS IN ADVANCE OF ALL OTHER ROUTES!

Sixty-One Miles the Shortest Line! Only 27 Hours!

— FROM —

CHICAGO TO NEW YORK.

Pittsburgh, Ft. Wayne & Chicago and Pennsylvania Central

IS THE ONLY ROUTE RUNNING ITS ENTIRE TRAIN THROUGH TO PHILADELPHIA AND NEW YORK, AND THE ONLY ROUTE RUNNING

THREE DAILY LINES OF PULLMAN'S DAY AND SLEEPING PALACES,

— FROM CHICAGO TO —

PITTSBURGH, HARRISBURG, PHILADELPHIA & NEW YORK

WITHOUT CHANGE!

WITH BUT ONE CHANGE TO

BALTIMORE, PROVIDENCE, NEW HAVEN,

HARTFORD, SPRINGFIELD, WORCESTER AND BOSTON!

And the Most Direct Route to Washington City.

Trains Leave WEST SIDE UNION DEPOT, corner West Madison and Canal Streets, as follows:

LEAVE:	Mail	Fast Express.	Pacific Exp.	Night Exp.	VALPARAISO ACCOMMODATION, Leaves CHICAGO daily, (except Sunday,) at 4.50 P.M.
CHICAGO	5.50 A. M.	11.00 A. M.	5.15 P. M.	9.00 P. M.	
PLYMOUTH	9.50 "	1.50 P. M.	s. 9.10 "	2.13 A. M.	
FORT WAYNE	12.40 P. M.	3.20 "	11.30 "	n. 5.30 "	
LIMA	3.15 "	.... "	1.25 A. M.	8.10 "	
FOREST	4.37 "	.... "	2.48 "	9.40 "	
CRESTLINE	6.00 A. M.	s. 6.55 "	4.30 "	D.12.05 P. M.	
MANSFIELD	6.42 "	7.16 "	5.00 "	12.34 "	
ORRVILLE	9.05 "	8.42 "	6.45 "	2.27 "	
ALLIANCE	10.45 "	9.55 "	n. 8.40 "	3.55 "	
ROCHESTER	D. 2.05 P. M.	12.17 A. M.	10.52 "	6.02 "	South'n Exp.
PITTSBURGH	3.15 "	12.50 "	12.45 P. M.	s. 7.50 "	5.30 A. M
BLAIRSVILLE BRANCH	6.05 "	.... "	2.49 "	9.54 "	7.23 "
JOHNSTOWN	6.56 "	.... "	3.37 "	10.42 "	8.08 "
CRESSON	7.58 "	.... "	4.38 "	11.43 "	9.04 "
ALTOONA	s. 9.05 "	n. 4.40 "	s. 5.45 "	12.35 A. M.	n.10.05 "
HUNTINGDON	10.21 "	.... "	7.04 "	1.45 "	11.14 "
LEWISTOWN	11.44 "	.... "	8.23 "	2.59 "	12.25 P. M.
HARRISBURG	2.10 A. M.	8.23 "	10.45 "	5.20 "	D. 2.50 "
LANCASTER	3.40 "	.... P. M.	12.15 A. M.	7.00 "	4.10 "
DOWNINGTON	5.00 "	.... "	1.40 "	n. 8.16 "	5.35 "
ARRIVE:					
PHILADELPHIA	6.30 "	12.20 "	3.10 "	9.40 "	7.00 "
NEW YORK, VIA PHILADELPHIA	10.41 "	3.00 "	6.43 "	1.00 P. M.	10.36 "
NEW YORK, VIA ALLENTOWN	....	3.50 "	....	12.05 P. M.	....
BALTIMORE	....	12.10 "	4.20 "	9.00 A. M.	7.00 "
WASHINGTON	....	3.40 "	5.50 "	1.00 P. M.	10.00 "
BOSTON	9.00 P. M.	5.50 A. M.	5.05 P. M.	11.50 "	....

THE FAST EXPRESS Leaves Chicago daily, except Sunday; the entire Train,—Baggage, Day and Pullman's Palace Cars—RUNNING THROUGH from Chicago to New York, via Mantua Junction; leaves Pittsburgh daily, except Monday. This train **reaches NEW YORK in time to make close connection for BOSTON!** No other Route through New York makes it! Arrives in BALTIMORE **Five Hours,** and WASHINGTON **Four Hours in Advance of Rival Routes!**

THE PACIFIC EXPRESS Leaves Chicago and Pittsburgh daily, for Philadelphia and New York, with PULLMAN PALACE CARS from Chicago; leaves Harrisburg for Baltimore daily, except Sunday; has SLEEPING CARS from Chicago to Pittsburgh, and from Altoona to Philadelphia. This train arrives in BALTIMORE **Nine Hours,** and WASHINGTON **Seven Hours, in advance of all other Lines!**

THE NIGHT EXPRESS Leaves Chicago daily, except Saturday and Sunday; leaves Pittsburgh daily, except Sunday; leaves Harrisburg for Baltimore daily; has PULLMAN'S PALACE CARS from Chicago to Philadelphia and New York; has SLEEPING CARS from Chicago to Crestline, and from Pittsburgh to New York, Philadelphia and Baltimore. This train reaches BALTIMORE **Three Hours in Advance of competing Routes!**

THE MAIL Leaves Chicago daily, except Sunday, stopping at all Stations, and reaching Crestline the same evening [where passengers can transfer to Day Express]; leaves Crestline [Express,] the next morning, and leaves Pittsburgh daily, except Sunday. SLEEPING CARS from Pittsburgh to Philadelphia.

THE SOUTHERN EXPRESS Leaves PITTSBURGH daily, except Monday, with SILVER PALACE CARS to Philadelphia and New York; leaves Harrisburg for Baltimore daily, except Sunday.

BOSTON AND NEW ENGLAND PASSENGERS will find this Route especially Desirable, as it Gives them an opportunity of Seeing the FINEST VIEWS AMONG THE ALLEGHANY MOUNTAINS,

Besides Visiting PITTSBURGH, PHILADELPHIA and NEW YORK, without extra cost!

All New England Passengers holding Through Tickets, will be Transferred, with their Baggage, to Rail and Boat Connections in NEW YORK, WITHOUT CHARGE.

Close Connections Made at Lima for all Points on the Dayton & Mich. and Cin., Hamilton & Dayton R'ys,

And at CRESTLINE, for CLEVELAND, ERIE, DUNKIRK, BUFFALO, NIAGARA FALLS, and all Points reached via Lake Shore R.R.

THROUGH TICKETS for sale at the Company's Offices, at 65 Clark St., and also at 52 Clark St.; cor. Randolph and Wells St.; at N. E. corner of Randolph and LaSalle Sts.; and at Depot, Chicago. Also at Principal Ticket Offices in the West.

F. R. MYERS, Gen. Pass. and Ticket Agt, P. & F. W. R'y, Chicago. W. C. CLELAND, Gen. Western Pass. Agt, P. Ft. W. & C. R'y, Chicago.

T. L. KIMBALL, Gen. Western Pass. Agent, Penn. Central R. R., Chicago.

J. H. LINVILLE, PRESIDENT. J. L. PIPER, GEN. MANAGER. A. G. SHIFFLER, SUP'T & TREAS.

The Keystone Bridge Company

OF PITTSBURGH, PENN.

Office and Works, 9th Ward, Pittsburgh, Pa. Philadelphia Office, 426 Walnut Street.

GENERAL WESTERN OFFICE:—13 Fullerton Block, 94 Dearborn St., CHICAGO, ILL.

This Company possess unrivaled facilities for manufacturing and erecting every description of **Iron and Wooden Railway and Road Bridges, Roofs, Turn-Tables and Buildings, "Linville and Piper" Patent Iron Bridges, Self-Sustaining Pivot Bridges, Suspension Bridges, and Ornamental Park Bridges.** Contractors for Wooden or Iron Bridges of any pattern, as per plans and specifications. Circulars sent on application.

WALTER KATTE, ENGINEER. A. D. CHERRY, SECRETARY.

PITTSBURGH CAST STEEL SPRING WORKS.

A. French & Co.,

Manufacturers of Extra Tempered, Light Elliptic

CAST STEEL SPRINGS,

FOR RAILROAD CARS AND LOCOMOTIVES,

FROM BEST CAST STEEL.

OFFICE AND WORKS:—Cor. Liberty and 21st Sts., PITTSBURGH, PA.

CHICAGO BRANCH, 88 Michigan Ave.

Broad Gauge! Double Track!

ERIE RAILWAY.

4 EXPRESS TRAINS DAILY!

From Cleveland, Dunkirk and Buffalo, 625 Miles, to New York, WITHOUT CHANGE of Coaches!

The Trains of this Railway are run in DIRECT CONNECTION WITH ALL WESTERN AND SOUTHERN LINES, for

Elmira, Williamsport, Oswego, Great Bend, Scranton, Newburgh,

NEW YORK, ALBANY, BOSTON, PROVIDENCE,

AND PRINCIPAL NEW ENGLAND CITIES.

New and Improved DRAWING ROOM COACHES are attached to the DAY EXPRESS Running THROUGH TO NEW YORK.

SLEEPING COACHES, Combining all Modern Improvements, with perfect Ventilation and the peculiar arrangements for the comfort of Passengers incident to the **BROAD GAUGE,** accompany all night trains to New York.

CONNECTIONS CERTAIN! as Trains on this Railway will, when necessary, **wait from one to two hours for Western trains.**

All Trains of Saturday run directly Through to New York.

Ask for Tickets via Erie Railway, which can be procured at **66 Clark Street,** Chicago, and at all Principal Ticket offices in the West and Southwest.

L. D. RUCKER, Gen'l Superintendent, New York. | **A. J. DAY,** Western Passenger Agent, Chicago. | **WM. R. BARR,** Gen'l Passenger Agent, New York

LAKE SHORE
—AND—
MICHIGAN SOUTHERN R.W.

THE GREAT THROUGH LINE BETWEEN

CHICAGO, BUFFALO & NEW YORK,

WITHOUT CHANGE!

AND THE ONLY RAILWAY

RUNNING PALACE COACHES THROUGH!

— BETWEEN —

CHICAGO & NEW YORK, via BUFFALO

☞ WITHOUT TRANSFER OF PASSENGERS! ☜

All Trains Stop at Twenty-Second Street to Take and Leave Passengers. Baggage Checked at that Station for all Points East.

4 EXPRESS TRAINS DAILY, [Sundays Excepted,] Leave CHICAGO from the New Depot, on Van Buren St., at the head of La Salle Street, as follows

7:30 A. M. MAIL TRAIN.
VIA OLD ROAD AND AIR LINE. SUNDAYS EXCEPTED.

Leaves 22d Street 7:45 A. M. Stops at all Stations. **Arrives**—Toledo, 6:20 P. M.

11:30 A. M. SPECIAL NEW YORK EXPRESS,
-A AIR LINE. SUNDAYS EXCEPTED.

Leaves—Twenty-Second Street, **11:45 A. M.** **Arrives**—Elkhart, 2:55 P. M.; Cleveland 10:40 P. M.; Buffalo, 4:10 A. M.; New York, 5:30 P. M.; (Chicago Time) Boston, 11:45 P. M.

This Train has PALACE SLEEPING COACH Attached, Running

THROUGH TO ROCHESTER, WITHOUT CHANGE!

IN DIRECT CONNECTION WITH

Wagner's Celebrated Drawing-Room Coaches on N. Y. Central R. R.

Only Thirty Hours, Chicago to New York!

5:15 P. M. ATLANTIC EXPRESS (Daily),
VIA OLD ROAD.

Leave—Twenty-Second Street **5:30 P. M.** **Arrives**—Laporte, 8:10 P. M. (Stops 20 minutes or Supper); arrives at Toledo, 2:50 A. M.; Cleveland, 7:25 A. M. (20 minutes for Breakfast); arrives at Buffalo, 1:50 P. M.; Rochester, 5:10 P. M. (20 minutes for Supper); connects with **Sleeping Coach running Through from Rochester to Boston Without Change,** making but **One Change between Chicago and Boston.**

NEW AND ELEGANT SLEEPING COACH Attached to this Train, Running THROUGH from CHICAGO TO NEW YORK WITHOUT CHANGE! Arrives at NEW YORK, 6:40 A. M.

9:00 P. M. NIGHT EXPRESS
VIA AIR LINE. (DAILY EXCEPT SAT. & SUN.)

Leaves—Twenty-Second Street, **9:15 P. M.** **Arrives**—Toledo, 6:00 A. M. (20 minutes for Breakfast); arrives at Cleveland, 10:35 A. M.; Buffalo, 5:30 P. M.; New York, 11:00 A. M.; Boston, 3:50 P. M.

KALAMAZOO DIVISION.

Leave Chicago 11:30 A. M. Arrive at Kalamazoo 6:05 P. M.; Grand Rapids, 9:25 P. M.

Leave Chicago 9:00 P. M. Arrive at Kalamazoo 6:50 A. M.; Grand Rapids, 9:40 A. M.

Elkhart Accommodation leaves Chicago, 3:30 P. M. Arrives at Elkhart, 8:20 P. M.

☞ There being no heavy grades to overcome, or mountains to cross, the road bed and track being the smoothest and most perfect of any railway in the United States, this Company run their trains at a high rate of speed with perfect safety.

☞ Travelers who wish to SAVE TIME and make SURE CONNECTIONS, purchase Tickets via

LAKE SHORE & MICHIGAN SOUTHERN R'Y.

THE ONLY LINE RUNNING THROUGH BETWEEN CHICAGO AND BUFFALO, WITHOUT TRANSFER, and in Direct Connection with NEW YORK CENTRAL RAILROAD and ERIE RAILWAY.

General Ticket Office for Chicago, No. 56 Clark Street.

CHAS. F. HATCH,
General Superintendent, CLEVELAND, OHIO

F. E. MORSE,
General Western Passenger Agent, CHICAGO.

ILLINOIS CENTRAL RAILROAD.

PASSENGER TRAINS LEAVE CHICAGO FROM THE GREAT CENTRAL DEPOT, FOOT OF LAKE ST

ST. LOUIS AND CHICAGO
THROUGH LINE.

9:30 A. M. DAY EXPRESS Sundays Ex
Arriving in ST. LOUIS at 10:15 P. M.

☞ This Train Reaches St. Louis ONE HOUR & FIFTEEN MINUTES in Advance of any other Route! ☜

8:30 P. M. FAST LINE. Saturdays Excepted.
Arriving at ST. LOUIS at 8:00 A. M.

AT ST. LOUIS, Direct Connections are Made FOR

Jefferson City, Sedalia, Pleasant Hill, Macon, Kansas City,

LEAVENWORTH, ST. JOSEPH & ATCHISON,

—Connecting at KANSAS CITY for—

LAWRENCE, TOPEKA, JUNCTION CITY, SALINA, SHERIDAN, &c.

CAIRO, MEMPHIS AND NEW ORLEANS LINE.

9:30 A. M. CAIRO MAIL, Sundays Excepted.
Arriving at **Cairo** 2:20 A. M., **Memphis** 12:40 P. M., **Mobile** 9:40 A. M **Vicksburg** 9:30 A. M., **New Orleans** 11:10 A. M.

8:30 P. M. CAIRO EXPRESS, Except Saturdays.
Arriving at **Cairo** 3:15 P. M., **Memphis** 2:30 A. M., **Vicksburg** 5:00 P. M., **New Orleans** 1:30 A. M.

4:55 P. M. CHAMPAIGN PASSENGER,
Arriving at **Champaign** at 11:15 P. M.

☞ **THIS IS THE ONLY DIRECT ROUTE TO**

Humboldt, Corinth, Grand Junction, Little Rock, Selma, Canton, Grenada, Columbus, Meridian, Enterprise,

MEMPHIS, VICKSBURG, NEW ORLEANS & MOBILE.

At NEW ORLEANS, connections are made for

GALVESTON, INDIANOLA,

And all Parts of Texas.

☞ **NOTICE.—This Route is from 100 to 150 MILES SHORTER, and from 12 to 24 HOURS QUICKER than any other.**

THIS IS ALSO THE ONLY DIRECT ROUTE TO

DECATUR, TERRE HAUTE, VINCENNES & EVANSVILLE.

Peoria and Keokuk Line.

9:30 A. M. KEOKUK PASSENGER, Sun. Excepted.
Arriving at **Chenoa** 3:15 P. M., **El Paso** 4:05 P. M., **Peoria** 5:40 P. M., **Canton** 7:14 P. M., **Bushnell** 8:59 P. M., **Keokuk** 11:26 P. M., **Warsaw** 12:05 A. M.

Elegant Drawing Room Sleeping Cars

ATTACHED TO ALL NIGHT TRAINS.

Spacious and Fine Saloon Cars!

WITH ALL MODERN IMPROVEMENTS, RUN UPON ALL TRAINS.

BAGGAGE CHECKED THROUGH TO ALL IMPORTANT POINTS.

☞ For Through Tickets, Sleeping Car Berths, Baggage Checks, and information, apply at the office of the Company in the Great Central Depot, foot of Lake St.

Hyde Park and Oakwoods Train.

	LEAVE.	ARRIVE.		LEAVE.	ARRIVE.
HYDE PARK TRAIN,...	*6:20 A. M.	*7.45 A. M.	HYDE PARK TRAIN,....	*2:00 P. M.	*3:15 P. M.
HYDE PARK TRAIN....	*8:00 A. M.	*9.15 A. M.	HYDE PARK TRAIN,....	*6:10 P. M.	*7:35 P. M.
HYDE PARK TRAIN,..	*12:10 P. M.	*1:50 P. M.			

* Sundays Excepted.

W. P. JOHNSON, Gen. Pass. Agent. **M. HUGHITT, Gen. Supt.**

1870. Great Central Route! 1870.

SPEED! COMFORT! SAFETY!

MICHIGAN CENTRAL and GREAT WESTERN RAILWAYS!

The Great Central Route, via Niagara Falls, to

NEW YORK AND NEW ENGLAND.

Pullman's Magnificent Palace Drawing-Room Cars,

— FROM —

CHICAGO TO NEW YORK CITY, WITHOUT CHANGE.

4 PASSENGER TRAINS LEAVE CHICAGO, DAILY EXCEPT SUNDAY.
(DEPOT, FOOT OF LAKE STREET,) as Follows:

5:00 A. M. (SUNDAYS EXCEPTED.) MAIL TRAIN. Stops at all Stations.
Arrives DETROIT at 5:40 P. M.

11:30 A. M. (SUNDAYS EXCEPTED.) SPECIAL NEW YORK & BOSTON EXP.
Arrives at Michigan City 1:13 P. M.; New Buffalo 1:33, Niles 2:15, [Dinner], Kalamazoo 3:52 P. M.; Battle Creek 4:28, Marshall 4:48, Jackson 5:45, Detroit 7:55, London 12:05, A. M. Hamilton 2:35 A. M.; Toronto 9:20, Suspension Bridge 3:55, Rochester 7:00 A. M.; Albany, 2:00 P. M.; NEW YORK, 6:25, BOSTON, 11:50 P. M. ☞ This train connects at ROCHESTER (7:00 A. M.) with

Wagner's Magnificent Palace Drawing-Room Cars!

☞ RUNNING THROUGH TO NEW YORK, WITHOUT CHANGE! ☜

5:15 P. M. (DAILY.) ATLANTIC EXPRESS.
Arrives at Michigan City, 7:18 P. M.; Niles 8:30 P. M. [Supper]; Kalamazoo, 10:25 P. M.; Jackson, 1:00 A. M.; Detroit 3:40, London, 8:35, [Breakfast]; Hamilton 11:40, Suspension Bridge 1:30 P. M.; Rochester 5:00 P. M.; Albany, 1:30 A. M.; NEW YORK, 6:40 A. M.; BOSTON, 11:00 A. M.
A MAGNIFICENT DRAWING-ROOM SLEEPING CAR is attached to this train daily, FROM CHICAGO TO NEW YORK CITY. The celebrated

☞ **Hotel Drawing-Room Car is also attached to this Train from Chicago to Rochester!** ☜

☞ These, together with **ELEGANT DAY CARS TO SUSPENSION BRIDGE,** make this Train the favorite Train for all points East.

SPECIAL NOTICE.—Boston and New England Passengers will please notice that this Train now makes direct connection through. A SLEEPING CAR is attached at Rochester at 5.20 P. M., running through to Springfield, Mass., thus avoiding transfer at Albany. Breakfast at Springfield. This Train reaches Springfield early enough second morning to **Connect with all Trains** up and down the Connecticut.

9:00 P. M. (SAT. & SUN. EXCEPTED). NIGHT EXPRESS.
Arrives at Michigan City, 11:03 P. M.; Niles, 12:25 A. M.; Kalamazoo, 2:00; Marshall, 3:12; Jackson, 4:25; Grand Trunk Junction, 7:00; Detroit, 7:30; London, 1:45 P. M.; Hamilton, 4:35; Toronto, 9:35; Niagara Falls, 6:15; Buffalo, 7:15 P. M.; Rochester, 9:10; Syracuse, 12:25 A. M.; Rome, 1:55; Utica, 2:25; Albany, 6:30 A. M.; NEW YORK, 10:00 A. M.; BOSTON, 3:40 P. M.

PULLMAN'S PALACE SLEEPING CARS ARE ATTACHED TO THIS TRAIN FROM CHICAGO TO DETROIT,
And from Suspension Bridge to New York.

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